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HUMAN INFESTATIONS WITH ASCARIS AND TRICHURIS IN DIFFERENT PARTS OF THE PHILIPPINE ISLANDS

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FOUR TEXT FIGURES

Recently the writers made a quantitative survey of human intestinal parasites in different places in the Philippines in connection with an investigation on the anthelmintic efficiency of hexylresorcinol against *Ascaris lumbricoides, Trichuris trichiura,* and hookworms. The data obtained have been compiled and those on ascaris and trichuris are presented in this paper. Although there already exists a large volume of literature on the occurrence of these parasites in the Philippines, these available records are mostly in the form of incidence statistics. Recent surveys made in other parts of the world have shown that data of this sort do not portray accurately the true picture of parasitic infestations, for they do not distinguish between cases that are only slightly infested and those that are heavily parasitized. On the other hand, quantitative data, such as those obtained by the Stoll egg-counting technic, express the probable worm burden of an infested individual or of a population, for which reason they are considered more trustworthy and more useful in epidemiological surveys, especially in measuring the efficiency of treatments and control measures.

PLACES SURVEYED AND TIME OF YEAR

The bulk of our work was carried out in three places during different times of the year as follows: in Manila from July 25

to September 23, 1932; in Pardo, Cebu, from April 10 to 30, 1933; and in Paombong, Bulacan, from May 15 to June 3, 1933. It was planned to conduct the survey in more than one locality in order to find as great a variety of cases as possible for treatment with hexylresorcinol and at the same time to have an opportunity to determine some of the factors which might be involved in the distribution of intestinal parasites in the Philippines. The places mentioned were selected as representative of three distinct areas differing in social, sanitary, and economic development. Manila is a big city with a modern public-health service and represents, therefore, a typically urban environment. Pardo and Paombong, on the other hand, are rural communities lacking approved sanitary conveniences. The method of waste disposal in these two communities is primitive. As far as we were able to ascertain, in neither of the three places visited had there been conducted any worthwhile campaign against intestinal parasites during the last five years.

MATERIALS AND METHODS

The total number of persons examined was 1,393 distributed as follows: 503 in the City of Manila, 489 in Pardo, Cebu, and 401 in Paombong, Bulacan. Those examined in Manila were school children, 7 to 11 years of age and studying in the Magdalena Elementary School; those in Pardo and Paombong represented mixed populations.

Individual fæcal samples were collected in ordinary Petri dishes between two circular pieces of paraffined paper. The purpose of the latter was to facilitate the cleaning of the dishes. Uusally from forty to fifty of these containers were distributed in the afternoons and collected on the following mornings. As soon as the specimens were received in the laboratory, they were classified as to consistency and then prepared for egg-counting according to the displacement method of Stoll and Hausheer (1926). In recording the egg counts the figures were brought to the formed basis (Stoll, 1929) and corrected for size (Cort, Otto, and Spindler, 1930).

RESULTS OF EGG COUNTS FOR ASCARIS

For purposes of comparison the results of the fæcal examinations are given separately for each area surveyed. In Table 1 is shown the incidence of ascaris infestation and the egg counts analyzed according to age and sex.

Pardo, Cebu, Cebu.—Of the 489 persons examined 253 were males and 236 females. The males showed an ascaris incidence of 80.2 per cent and an average count of 15,960 eggs per cc of fæces. The incidence in the females was slightly lower, 78.8 per cent, but the average count was higher or 17,780 eggs per cc. The incidence in the entire Pardo series was thus 79.5 per cent and the average egg count 16,800 per cc. These figures, if corrected for a standard population according to the suggestion of Sweet (1929), would be as follows: the incidence in the males 80.7 per cent and the average egg count 14,750 per cc; the incidence in the females 79.5 per cent and the average egg count 17,250; the incidence in both sexes 78.1 per cent and the average count 16,000 per cc. Considering only the positive cases in order to indicate the intensity of the infestations, the averages were 20,200 eggs per cc in the two sexes, 18,400 in the males alone and 22,000 in the females. These are fairly high egg counts, the corrected figures indicating an average worm burden of 16 adult ascaris in the entire series of 489 individuals.[1] They approximate those obtained by Cort, Stoll, Riley, and Sweet (1929) in Panama, but our incidence percentages are much higher than those of the Panama series. They are also higher than most of the incidence percentages published by the earlier workers in the Philippines. Among the latter only Garrison, Leynes, and Llamas (1909) and Willets (1913) in surveys conducted in Taytay, Rizal, and in the Batanes Islands, respectively, reported incidences of ascaris infestations of a little over 79.5 per cent.

The characteristic distribution of ascaris in a mixed population is clearly shown in Table 1. When the individuals examined are classified into conventional age groups, the incidence of the parasite is much higher in younger than in older persons, the percentage of infestation being 95.9 per cent in the 196 individuals up to 14 years of age and only 68.5 per cent in the remaining 293 persons 15 years old and over. The same difference is observed between the two groups in regard to their egg counts, the average worm burden of the younger individuals being more

[1] From the egg counts the probable number of adult ascaris harbored by an individual may be estimated by dividing the number of eggs per cc. of stools by 1,000. In the use of this factor it is considered that the egg production per adult female ascaris is 2,000 per cc of fæces and the number of male and female worms approximately equal (Cort and Stoll, 1931).

TABLE 1.—*Results of egg counts for ascaris classified according to age and sex. The figures in parentheses represent the average counts of positive cases only.*

MALES.

Age group.	Pardo, Cebu.				Pacombong, Bulacan.				Manila.			
	Cases.	Positive.	Incidence.	Average egg count per cc.	Cases.	Positive.	Incidence.	Average egg count per cc.	Cases.	Positive.	Incidence.	Average egg count per cc.
Years.			P. ct.				P. ct.				P. ct.	
0– 4	16	15	93.7	14,150 (15,100)	26	19	73.1	11,280 (15,430)				
5– 9	44	42	95.4	23,680 (24,800)	34	34	100.0	23,990 (23,990)	166	137	82.5	26,340 (39,910)
10–14	46	45	97.8	35,230 (36,010)	19	17	89.5	44,230 (49,430)	93	80	86.0	31,320 (36,410)
15–19	23	18	78.2	12,000 (15,300)	10	8	80.0	21,600 (27,000)				
20–24	29	19	65.5	6,510 (9,940)	17	14	82.3	8,330 (10,110)				
25–29	27	18	66.6	5,700 (8,540)	25	15	60.0	5,780 (9,630)				
30–34	11	9	81.8	8,750 (10,700)	16	10	62.5	10,020 (16,040)				
35–39	17	12	70.6	6,930) (9,820)	7	4	57.1	8,260 (14,450)				
40–44	10	5	50.0	3,880 (7,760)	16	6	37.5	6,120 (16,330)				
45–49	11	7	63.6	15,000 (23,500)	6	5	83.3	15,870 (19,040)				
50+	19	13	68.4	5,070 (8,880)	23	8	34.8	5,030 (14,460)				
Total or average	253	203	80.2	15,960 (19,900)	199	140	70.3	14,960 (20,700)	259	217	83.8	28,090 (33,570)

FEMALES.

0- 4	18	17	94.4	15,400 (16,300)	19	15	78.9	18,610 (23,580)				
5- 9	29	29	100.0	32,700 (32,700)	23	22	95.6	23,790 (24,870)	155	131	84.5	25,710 (30,420)
10-14	43	40	93.0	28,350 (30,470)	29	26	89.6	22,880 (25,520)	89	77	86.5	36,530 (41,750)
15-19	23	16	69.6	15,100 (21,720)	28	23	82.1	20,410 (24,840)				
20-24	27	18	66.6	12,300 (18,400)	20	19	95.0	21,440 (22,570)				
25-29	25	19	76.0	12,900 (17,000)	20	14	70.0	7,930 (11,330)				
30-34	18	14	77.7	18,950 (24,370)	12	7	58.3	10,600 (18,000)				
35-39	13	9	69.2	10,680 (15,420)	13	8	61.5	8,680 (14,100)				
40-44	8	4	50.0	4,900 (9,800)	10	6	60.0	2,880 (4,800)				
45-49	8	4	50.0	17,350 (34,700)	4	2	50.0	2,900 (5,800)				
50+	24	16	66.6	3,780 (5,680	4	16	66.7	12,520 (18,770)				
Total or average	236	186	78.8	17,780 (22,560)	202	158	78.2	16,350 (21,300)	244	208	85.2	29,660 (34,790)

than twice that of the older ones. As a matter of record the highest individual counts in the two sexes were 137,600 and 160,800 eggs per cc and were met with in a boy 10 years old and in a girl 11 years old, respectively.

A comparison of the counts of the different age groups is shown graphically in text figure 1. In the males the average

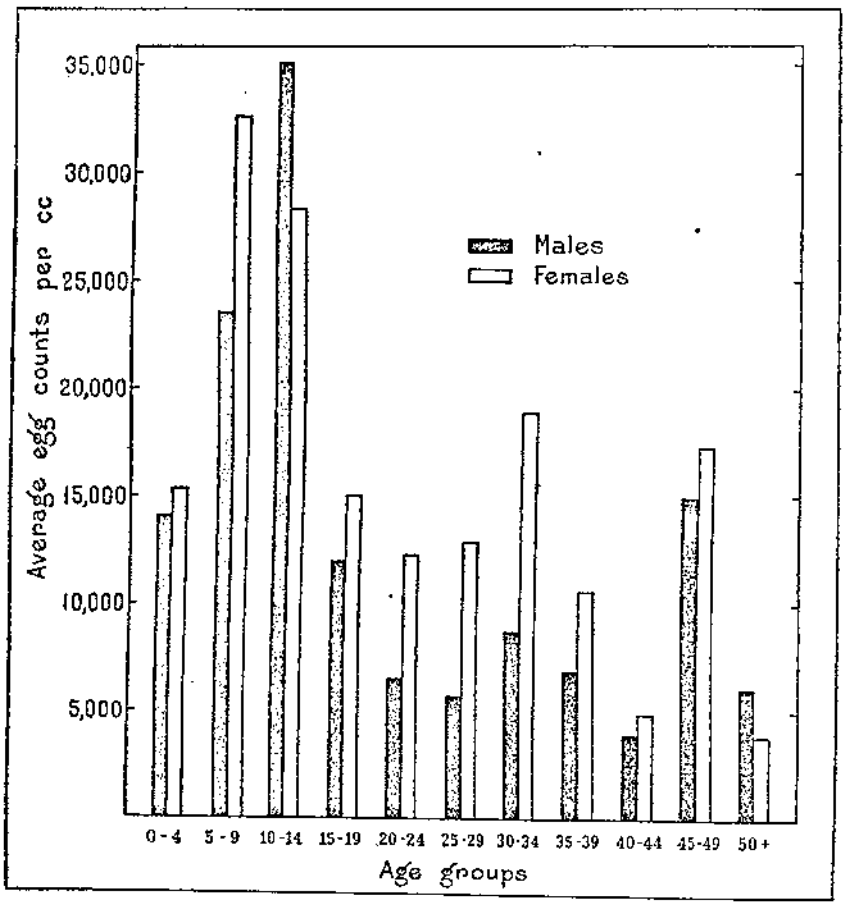

FIG. 1. Showing average ascaris egg counts of Pardo series. See Table 1.

count of 14,150 eggs per cc in the group 0 to 4 years old is comparatively high, but the counts are much higher in the next two groups, the peak of the egg count curve occurring in the 10- to 14-year group and representing an average of 35,230 eggs per cc. The curve then falls abruptly in the 15- to 19-year group and continues to fall in the succeeding age groups with no tendency to rise except in the 45- to 49-year group. In the fe-

male series the average counts are also high in the younger groups, the peak of the curve occurring in the 5- to 9-year group and representing 32,700 eggs per cc. In the 10- to 14-year group the curve drops slightly to 28,350 eggs per cc. Then there is a sudden drop to 15,100 in the 15- to 19-year group, but in contrast to what has been observed in the males, the curve is maintained more or less at that level in the succeeding groups, except in the 40- to 44- and 50-year and over groups. The average egg count of females over 15 years old is about twice that of males of the same age.

TABLE 2.—*Ascaris infestations of Pardo series classified according to intensity groups.*

MALES.

Ascaris infestation groups in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+ yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	4	3.8	24	30.4	12	31.6	10	33.3	50	19.8
1–10,000	36	33.9	37	46.9	19	50.0	13	43.3	105	41.5
10,001–50,000	48	45.3	16	20.2	6	15.8	5	16.7	75	29.6
50,001–100,000	13	12.3	2	2.5	1	2.6	2	6.7	18	7.1
100,001+	5	4.7	0	.....	0	0	0	0	5	2.0
Total	106	100.0	79	100.0	38	100.0	30	100.0	253	100.0
FEMALES.										
Negative	4	4.4	22	29.3	12	30.8	12	37.5	50	21.2
1–10,000	32	35.6	25	33.3	14	35.9	15	46.9	86	36.4
10,001–50,000	36	40.0	24	32.0	10	25.6	4	12.5	74	31.4
50,001–100,000	15	16.7	3	4.0	2	5.1	0	.....	20	8.5
100,001+	3	3.3	1	1.3	1	2.6	1	3.1	6	2.5
Total	90	100.0	75*	99.9	39	100.0	32	100.0	236	100.0

In Table 2 an analysis of the individual infestations into intensity groups is given. Here again the same differences already noted in the distribution of ascaris in a mixed population are evident. In the first place it is shown that about 60 per cent of all the persons examined, 73 per cent of those at least 15 years of age, and only 38 per cent of those up to 14 years old, fall in the negative and lowest egg count groups, in which the estimated number of adult worms harbored is not more than 10. On the other hand, there were 49 cases in the highest egg count groups, that is, those with more than 50,000 eggs per cc, of which 36 or 73 per cent were met with in young individuals up to 14 years old. These 36 cases represent only

about 7.4 per cent of the 489 persons examined, but the sum of their egg counts constitutes 60 per cent of that of the entire series. Considering the sexes separately, of the males 7.1 per cent, all of them young, carry 55 per cent of the total worm burden of the males and of the females 7.6 per cent carry 62 per cent of the total count of the females. These findings are in accord with those of other workers who observed that there is a tendency in ascaris infestation for a large percentage of the worm burden to be concentrated in a small number of individuals. This, according to Cort (1931), is due to the fact that a combination of factors, such as, grossly polluted sources of infestation and very poor personal hygiene which are necessary to produce very heavy infestations, are rarely met with. The explanation given for the greater prevalence of the parasite in children is that the latter are more exposed to infestation on account of their playing on the ground and of their generally more insanitary habits.[2] Women of child-bearing age have also greater chances of being infested than adult males due to their closer association with children and to the greater proportion of time that they spend in and around the house. Curiously enough in our series the average count of women of child-bearing age is very similar to that of children between 0 and 4 years old.

Paombong, Bulacan.—As shown in Table 1, of the 401 individuals who were egg-counted in this town, 74.3 per cent were found positive for ascaris, the percentage being 70.3 per cent in the 199 males and 78.2 per cent in the 202 females. As in the Pardo series, the incidence was higher in the younger individuals, the infestation among 150 persons up to 14 years of age being 88.7 per cent and only 65.7 per cent among the 251 persons 15 years old and over. The average egg count of the entire series is 15,860 per cc, being 14,960 for the males and 16,350 for the females. These figures, if corrected for a standard population, would be 16,300 for both males and females, 16,800 for the males alone and 15,750 for the females. If the positive cases alone are considered, the average count of

[2] We have inquired into the possible sources of ascaris and trichuris infestations in Manila and Paombong by examining soil samples and other suspected objects for the embryonated ova of the two parasites according to the method of Caldwell and Caldwell, as described by Spindler (1929). Our findings conform with those of Brown (1927) and Otto, Cort, and Keller (1931) in that they point to soil pollution in the immediate surroundings of houses as the chief source of infestation.

the two sexes is 21,050, of the males alone 20,700 and of the females 21,300. In both males and females the average counts are comparatively high in the younger individuals, the peak of the average egg count curve occurring between 10 and 14 years in the males and between 5 and 9 years in the females. In the males the average counts become gradually smaller from the 15th year on; while in the females they are conspicuously high between 15 and 24 years, after which the curve is maintained at a low level as in the males.

TABLE 3.—*Ascaris infestations of Paombong series classified according to intensity groups.*

MALES.

Ascaris infestation groups in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	9	11.4	15	28.8	19	48.7	16	55.2	59	29.7
1–10,000	22	27.8	21	40.4	12	30.8	7	24.1	62	31.1
10,001–50,000	41	51.9	15	28.8	5	12.8	5	17.2	66	33.2
50,001–100,000	4	5.1	1	1.9	3	7.7	1	3.5	9	4.5
100,001+	3	3.8	0	-------	0	-------	0	-------	3	1.5
Total	79	100.0	52	99.9	39	100.0	29	100.0	199	100.0
FEMALES.										
Negative	8	11.3	12	17.6	14	40.0	10	35.7	44	21.8
1–10,000	27	38.0	28	41.2	10	28.6	9	32.1	74	36.6
10,001–50,000	29	40.8	20	29.4	11	31.4	7	25.0	67	33.2
50,001–100,000	4	5.7	8	11.8	0	-------	1	3.6	13	6.4
100,001+	3	4.2	0	-------	0	-------	1	3.6	4	2.0
Total	71	100.0	68	100.0	35	100.0	28	100.0	202	100.0

An analysis of the egg counts into intensity groups, as given in Table 3, shows that 59.6 per cent of all individuals examined, 68.9 per cent of those at least 15 years of age, and only 44 per cent of those between 0 and 14 years old, were found to be either free from ascaris or to have an average worm burden estimated to be not more than 10 adult parasites. As in the Pardo series, the greater bulk of the infestation was found concentrated in a few individuals (29 cases), 48.2 per cent of whom were young persons not over 14 years of age. These 29 cases constitute only 7.2 per cent of the 401 persons examined, but their total egg count represents more than 40 per cent of that of the entire series.

Manila.—As shown in Table 1, of the 503 school children examined in Manila 84.5 per cent were positive for ascaris, the

incidence being 83.8 per cent in the 259 boys and 85.2 per cent in the 244 girls. The average count of the entire series was 28,870, of the boys alone 28,090, and of the girls 29,660 eggs per cc of fæces. Considering only the positive cases, the average counts were 34,180 in both sexes, 33,570 in the males and 34,790 in the females.

TABLE 4.—*Ascaris infestation in 503 school children (ages 7 to 11 years) in Manila, arranged according to intensity groups.*

Ascaris infestation group in eggs per cc.	Males.		Females.	
		Per cent.		*Per cent.*
Negative	42	16.2	36	14.7
1–10,000	65	25.1	58	23.8
10,001–50,000	104	40.2	102	41.8
50,001–100,000	30	11.6	37	15.2
100,001+	18	6.9	11	4.5
Total	259	100.0	244	100.0

An analysis of the counts into intensity groups, as given in Table 4, shows that about 40 per cent of all the children examined belonged to the negative and lowest egg-count groups and only 19 per cent to the highest egg-count groups. The total count of the latter represents nearly 60 per cent of that of the entire group. Considering the sexes separately, 18.5 per cent of the boys had 58 per cent of the total count of all of the boys and 19.7 per cent of the girls had 59 per cent of the count of all of the girls. These figures show that even in a series composed entirely of school children there is a tendency for the greater bulk of the infestation to be concentrated in a limited number of individuals.

RESULTS OF EGG COUNTS FOR TRICHURIS

The data available for the study of trichuris infestation represent the results of the examination of the same individuals from which the ascaris counts were obtained. As in the case of the latter, they are given separately according to population groups for purposes of comparison (Table 5).

Pardo, Cebu, Cebu.—Of the 489 persons examined 431, or 88.1 per cent, were positive for trichuris, the incidences in the males and in the females being exactly the same. The average egg count of the entire series was 4,400, of the males alone 4,120, and of the females 4,630. These data would be as follows, if corrected for a standard population: Incidence in the

entire series 87.7 per cent, in the males alone 86.8 per cent, and in the females 88.6 per cent; egg count of the entire series 3,900, of the males alone 3,500, and of the females 4,300. Considering only the positive cases the average counts were 4,970 in the two sexes, 4,680 in the males and 5,260 in the females.

It will be noticed from the data presented in Table 5 that with the exception of the males between 30 and 34 years the

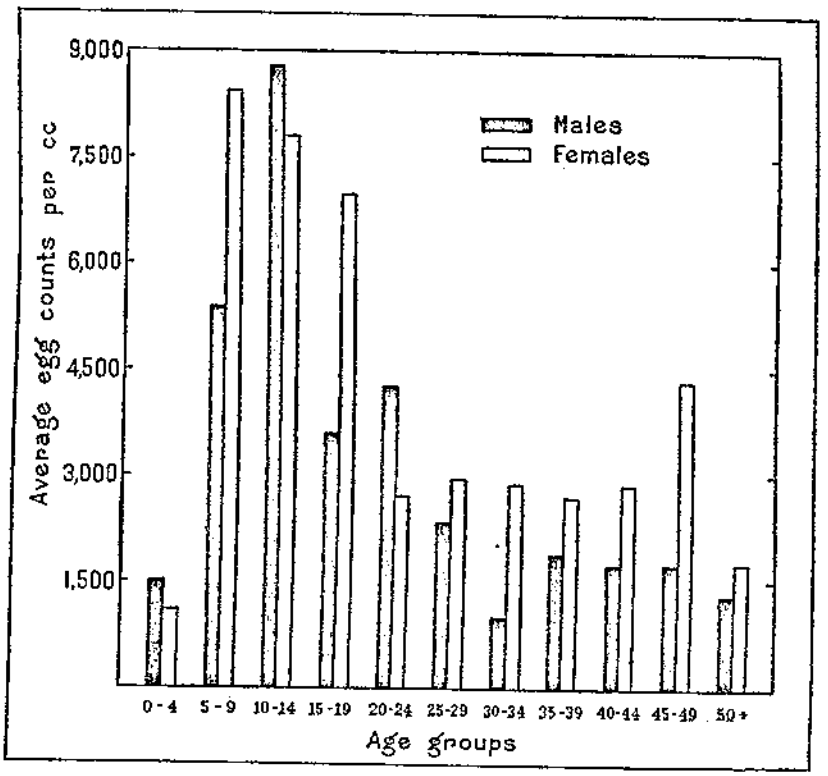

FIG. 2. Showing average trichuris egg counts of Pardo series. See Table 5.

incidence of trichuris in the various age groups is uniformly high, the differences occurring between the younger and older individuals not being as significant as those observed in ascaris infestations. With respect to the average egg counts, however, the same age and sex differences as were encountered in ascaris infestations are evident (text fig. 2). In both sexes the egg counts were low in young children between 0 and 4 years, the peak of the egg count curve in the males occurring between 10 and 14 years and in the females between 5 and 9 years. In

TABLE 5.—*Results of egg counts for trichuris classified according to age and sex. The figures in parentheses represent the average counts of positive cases only.*

MALES.

Age group.	Pardo, Cebu.				Paombong, Bulacan.				Manila.			
	Cases.	Positive.	Incidence.	Average egg count per cc.	Cases.	Positive.	Incidence.	Average egg count per cc.	Cases.	Positive.	Incidence.	Average egg count per cc.
Years.			*P. ct.*				*P. ct.*				*P. ct.*	
0- 4	16	14	87.5	1,520 (1,730)	26	10	38.5	230 (600)				
5- 9	44	43	97.7	5,370 (5,500)	34	26	76.5	1,380 (1,810)	166	144	86.7	2,400 (2,770)
10-14	46	46	100.0	8,800 (8,800)	19	12	63.2	2,000 (3,170)	93	83	89.2	4,200 (4,700)
15-19	23	21	91.3	3,600 (3,940)	10	5	50.0	1,560 (3,120)				
20-24	29	24	82.7	4,280 (5,170)	17	12	70.6	1,010 (1,430)				
25-29	27	20	74.1	2,310 (3,160)	25	13	52.0	690 (1,380)				
30-34	11	6	54.5	1,020 (1,870)	16	9	56.3	770 (1,380)				
35-39	17	15	88.2	1,900 (2,160)	7	5	71.4	1,140 (1,600)				
40-44	10	8	80.0	1,740 (2,170)	16	10	62.5	820 (1,320)				
45-49	11	10	90.9	1,760 (1,910)	6	5	83.3	1,000 (1,200)				
50+	19	16	84.2	1,310 (1,500)	23	11	47.8	450 (940)				
Total or average	253	223	88.1	4,120 (4,680)	199	118	59.3	960 (1,620)	259	227	87.6	3,040 (3,480)

FEMALES.

0– 4	18	16	88.8	1,100 (1,240)	19	10	52.6	320 (600)				
5– 9	29	28	96.5	8,450 (8,750)	23	21	91.3	1,230 (1,350)	155	131	84.5	2,680 (3,170)
10–14	43	38	88.4	7,820 (8,850)	29	16	55.2	1,250 (2,270)	89	81	91.0	3,050 (3,360)
15–19	23	18	78.3	7,000 (8,890)	28	21	75.0	1,850 (2,470)				
20–24	27	24	88.8	2,720 (3,060)	20	10	50.0	660 (1,320)				
25–29	25	19	76.0	2,970 (3,900)	20	6	30.0	160 (540)				
30–34	18	15	83.3	2,910 (3,360)	12	5	41.7	330 (800)				
35–39	13	13	100.0	2,710 (2,710)	13	6	46.1	310 (670)				
40–44	8	8	100.0	2,900 (2,900)	10	5	50.0	400 (800)				
45–49	8	8	100.0	4,350 (4,350)	4	2	50.0	300 (600)				
50+	24	21	87.5	1,780 (1,990)	24	14	58.3	570 (970)				
Total or average	236	208	88.1	4,630 (5,260)	202	116	57.4	820 (1,430)	244	212	86.9	2,810 (3,240)

the males there is observed a marked reduction after the fourteenth year while in the females the drop occurs at least five years later. A comparison of the egg counts of adult individuals shows that the trichuris burden of the females is nearly twice as great as that of the males. These differences are most probably due to the same factors which have been mentioned as responsible for the distribution of ascaris in a mixed population, considering that both parasites have simple life cycles and identical modes of transmission.

TABLE 6.—*Trichuris infestations of Pardo series classified according to intensity groups.*

MALES.

Trichuris infestation group in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	3	2.8	14	17.7	9	23.7	4	13.3	30	11.9
1–1,000	19	17.9	21	26.6	13	34.2	9	30.0	62	24.5
1,001–2,500	18	17.0	18	22.8	9	23.7	14	46.7	59	23.3
2,501–5,000	22	20.8	8	10.1	3	7.9	1	3.3	34	13.4
5,001+	44	41.5	18	22.8	4	10.5	2	6.7	68	26.9
Total	106	100.0	79	100.0	38	100.0	30	100.0	253	100.0

FEMALES.

Negative	8	8.9	14	18.7	3	7.7	3	9.4	28	11.9
1–1,000	15	16.7	15	20.0	5	12.8	11	34.4	46	19.5
1,001–2,500	18	20.0	13	17.3	16	41.0	6	18.7	53	22.4
2,501–5,000	13	14.4	13	17.3	8	20.5	8	25.0	42	17.8
5,001+	36	40.0	20	26.7	7	18.0	4	12.5	67	28.4
Total	90	100.0	75	100.0	39	100.0	32	100.0	236	100.0

An analysis of the individual infestations into intensity groups, as given in Table 6, shows that 34 per cent of all the persons examined, 23 per cent of those between 0 and 14 years of age, and 61.7 per cent of those 15 years old and over, were either free from trichuris or only very slightly infested, as judged by their egg counts which were not more than 1,000 per cc of stools. In the heavily infested groups, that is, those with counts of more than 2,500 eggs per cc, there were 211 cases, of which 115 or 54.5 per cent were young individuals up to 14 years of age. These 115 cases had a total count representing 66 per cent of that of the entire series; but since they constitute 23.5 per cent of all the persons examined, it is shown that in trichuris infestations the tendency which has been observed in

ascaris infestations for the bulk of the worm burden to be concentrated in a small number of persons, does not occur. The highest individual counts were 56,000 and 60,000 in a 20-year-old male and in a 13-year-old female, respectively.

Paombong, Bulacan.—Of the 401 persons examined in this town 234, or 58.1 per cent, were positive for trichuris, the incidence in the 199 males being 59.3 per cent and in the 202 females 57.4 per cent. The average egg count of the entire series was 890, of the males alone 960, and of the females 820. These data would be as follows, if corrected for a standard population: Incidence in the entire series 58.4 per cent, in the males alone 59.3 per cent, and in the females 57.5 per cent; egg count of the entire series 890, of the males alone 1,020, and of the females 760. These are low averages compared with those of the Pardo series and seem to indicate that there are certain factors existing in Paombong, Bulacan, which operate against the development of heavy trichuris infestations.

TABLE 7.—*Trichuris infestations of Paombong series classified according to intensity groups.*

MALES.

Trichuris infestation group in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	31	39.2	22	42.3	15	38.4	13	44.8	81	40.7
1–1,000	26	32.9	15	28.8	12	30.8	10	34.5	63	31.7
1,001–2,500	8	10.1	11	21.2	10	25.6	5	17.2	34	17.1
2,501–5,000	10	12.7	1	1.9	1	2.6	1	3.5	13	6.5
5,001+	4	5.1	3	5.8	1	2.6	0	------	8	4.0
Total	79	100.0	52	100.0	39	100.0	29	100.0	199	100.0
FEMALES.										
Negative	24	33.8	31	45.6	19	54.3	12	42.8	86	42.6
1–1,000	27	38.0	24	35.3	12	34.3	11	39.3	74	36.6
1,001–2,500	11	15.5	5	7.3	4	11.4	5	17.9	25	12.4
2,501–5,000	6	8.5	5	7.3	0	------	0	------	11	5.4
5,001+	3	4.2	3	4.4	0	------	0	------	6	3.0
Total	71	100.0	68	99.9	35	100.0	28	100.0	202	100.0

An analysis of the individual counts into intensity groups, as given in Table 7, shows that nearly 76 per cent of the whole series belong to the negative and lowest egg count groups and only 9.5 per cent to the highest egg count groups. In the latter most of the counts were between 3,000 and 6,000, the only ex-

ceptions being the counts of 8,000 and 17,600 in a 10-year-old male and in a 19-year-old female, respectively.

Manila.—Of the 503 children examined, 439 or 87.3 per cent were positive for trichuris, the percentage in the 259 boys being 87.6 per cent and in the 244 girls 86.9 per cent. The average egg count of the entire series was 2,940, of the males alone 3,040, and of the females 2,810. If only the positive cases are considered, the average count of the whole group was 3,360, of the boys 3,480, and of the girls 3,240. An analysis of the counts into intensity groups, as given in Table 8, shows that 218 children, or 43 per cent, were either free from trichuris or only lightly infested with counts not exceeding 1,000 per cc of fæces and that 170 cases, or 34 per cent, were either moderately or heavily parasitized each with a count of more than 2,500 eggs per cc. The combined count of the latter constitutes nearly 80 per cent of that of the entire group, showing that in this, as in the Pardo series, the bulk of the infestation is not concentrated in such a small number of individuals as was found to be the case in ascaris infestation. The highest individual counts were 73,000 and 19,200 in a boy 11 years old and in a girl 12 years old, respectively.

TABLE 8.—*Trichuris infestation in 503 school children (ages 7 to 11 years) in Manila, arranged according to intensity groups.*

Trichuris infestation group in eggs per cc.	Males.		Females.	
		Per cent.		*Per cent.*
Negative	32	12.4	32	13.1
1–1,000	84	32.4	70	28.7
1,001–2,500	61	23.5	54	22.1
2,501–5,000	36	13.9	46	18.9
5,001+	46	17.8	42	17.2
Total	259	100.0	244	100.0

COMPARISON OF THE ASCARIS AND TRICHURIS INFESTATIONS OF THE THREE POPULATION GROUPS EXAMINED

One would expect, as in fact it has been claimed due to apparently favorable climatic conditions, the distribution in the Philippines, especially in the unsanitated rural districts, of the common intestinal worms of man to be more or less uniform. Some of the earlier workers in tropical medicine in the Islands, however, must have suspected that such is not the case, for a number of them conducted surveys in widely separated places, obviously to learn something of the local geographical distribu-

tion of these parasites. Unfortunately very little progress in this direction was made, solely because of the fact that the apparently more accurate methods of field investigation which are now available were then unknown. Willets (1914) in particular examined cases from practically every province in the Archipelago, but the data he collected were only incidence statistics, from which he was unable to draw worthwhile conclusions. He merely noted that the distribution of the various intestinal parasites was extremely irregular, that in many instances very different results were obtained from adjacent northern and adjacent southern provinces.

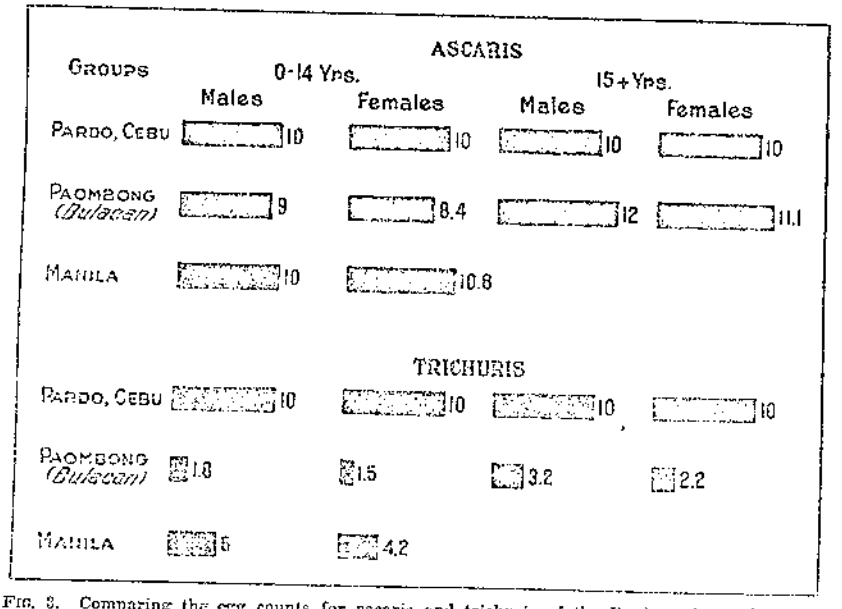

FIG. 3. Comparing the egg counts for ascaris and trichuris of the Pardo series with those of the Manila and Paombong series.

As stated in an earlier section of this paper, it has been shown by recent investigations that for epidemiological purposes quantitative data based on the egg output of intestinal worms are more accurate than incidence statistics. This being the case, a comparison of our three sets of egg counts for ascaris and trichuris with each other should give more valuable information regarding the distribution of these parasites in the Philippines. Such a comparison is shown in text figure 3, in which the average counts for the two parasites of children (0 to 14 years old) and adults (15 years and over) in the Pardo series,

classified according to sex, are each given a weight of 10 and the ratio to this figure of each of the corresponding counts in the Manila and Paombong series is calculated. It is evident from the bar diagrams that in the case of ascaris there are not very noticeable differences in the distribution of the parasite, the degree of infestation being about the same in the three groups. It is true that in the Paombong series the children show a slightly smaller worm burden, but the deficiency is made up by the somewhat higher counts of the adults. In the case of trichuris the differences are very marked, the average worm burden of those from Pardo being nearly five times as heavy as that of the Paombong group and about twice that of the Manila series. The significance of these observations is that in the three places where the examinations were conducted the conditions were equally favorable for the propagation of ascaris while the factors favoring the dissemination of trichuris were present to a greater extent in Pardo than in either Manila or Paombong.

To explain this difference in the distribution of the two parasites, reference should be made to the recent studies by Spindler (1929) and Otto (1929) on the biology of the eggs of these worms. According to these authors the ova of ascaris and trichuris are both resistant to many external conditions, but with the difference that the ova of trichuris are more easily destroyed by dessication and require more moisture for development than those of ascaris. It is suggested that this difference is probably the main reason why ascaris is so widely prevalent in different parts of the world while trichuris is mostly limited to those warm places where the soil is damp during the greater part of the year. The prevalence of ascaris in the Philippines could be explained in a similar manner, but to what extent the question of moisture enters as a factor in the local distribution of trichuris can only be determined by considering the amount and distribution of the annual rainfall and the effect of the shade of trees and other vegetation on the conservation of ground moisture. According to Father Coronas (1920) the monthly distribution of the annual rainfall in the Philippines may be classified into four types as follows: first type, in which there are two pronounced seasons—dry in winter and spring and wet in summer and autumm; second type, in which there is no dry season, with a very pronounced rain period in winter; third or intermediate A type, in which there is no very pronounced

rain period, with a short dry season lasting only for one to three months; fourth or intermediate B type, in which there is no very pronounced rain period and no dry season. Manila and Paombong are included among the regions having the first type and Pardo among those having the third type of rainfall distribution. Text figure 4 shows that although the annual rainfall of Pardo (1,530 mm) is less than that of either Manila (1,963 mm) or Paombong (2,103 mm)[3], it is more evenly distributed between the different months. Besides, there is in Pardo an abundance of coconut trees, especially around the houses, in contrast to the sparse vegetation in Manila and Paombong.

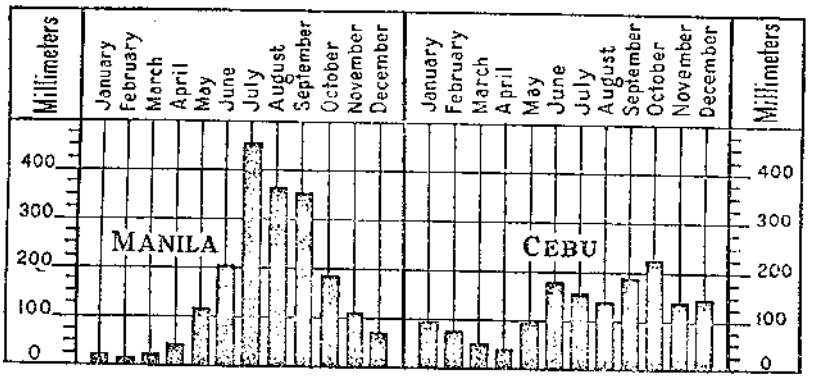

FIG. 4. Showing the monthly distribution of rainfall in Manila and Cebu. (From Coronas in the 1918 Census of the Philippine Islands.)

These factors taken together suggest a more uniform moisture content in the soil at Pardo, while in the other two places the soil is either too wet or too dry depending upon the time of the year. In other words there is in the former locality sufficient moisture throughout or during the greater part of the year for the development of trichuris eggs, while in Manila and Paombong the ground is so dry during certain months that trichuris ova are destroyed. For this reason the danger of building up heavy trichuris infestations is greater in Pardo than in the other two places.

[3] These data on annual rainfall are taken from the 1918 Census of the Philippine Islands. The information for Pardo is judged from the records of the climatological station at Cebu, which is about 6 kilometers from Pardo, that for Paombong from the records of the station at Marilao, which is about 22 kilometers from Paombong.

SIGNIFICANCE OF ASCARIS COUNTS OF CHILDREN IN MANILA

It was noted above that the egg counts for ascaris of children in Manila were as high as those of children in Pardo and Paombong, indicating the presence in these three places of sources of infestation to which the people are exposed. This finding calls for some comment in view of the fact that Manila with its modern system of waste disposal should possess certain sanitary advantages over Pardo and Paombong, which are not as well sanitated. The inference, therefore, is that not all of the members of the community in Manila take advantage of the available sanitary facilities, as otherwise soil pollution could not occur and the propagation of the parasite could not take place to the extent suggested by the high egg counts (see footnote 2 on page 98). In this connection our observations made in some of the poorer and more crowded sections of the city, where the large majority of the children examined reside, have shown that, as in most other places where ascariasis prevails, it is the children, especially those of preschool age, who are mainly responsible for the pollution of the ground. And since it has been shown that it is the children who are most subject to ascariasis, the conclusion is that they are mostly responsible for the spread of the parasite. For this reason, as pointed out by Cort (1933), in any campaign against ascariasis, if successful results are to be expected, special efforts must be exerted to control the promiscuous defecation of young children.

SUMMARY

A quantitative parasitological survey by means of the Stoll egg counting technic was conducted in three different places in the Philippine Islands in connection with an investigation on the anthelmintic efficiency of hexylresorcinol against the common intestinal worms of man. A total of 1,393 persons were examined, distributed as follows: 489 in Pardo, Cebu, Cebu; 401 in Paombong, Bulacan, Luzon; and 503 in the City of Manila. Those from Pardo and Paombong were mixed populations, while those from Manila were school children 7 to 11 years old.

The results of the egg counts for ascaris were as follows: Pardo series, incidence 79.5 per cent, average count 16,800 eggs per cc of fæces; Paombong series, incidence 74.3 per cent, average egg count 15,860; Manila series, incidence 84.5 per cent, average egg count 28,870.

The results of the egg counts for trichuris were as follows: Pardo series, incidence 88.1 per cent, average egg count 4,400; Paombong series, incidence 58.1 per cent, average egg count 890; Manila series, 87.3 per cent, average egg count 2,940.

An analysis of the counts for ascaris showed that in a mixed population the incidence is higher and the degree of infestation heavier in children (0 to 14 years old) than in adults (15 years old and over), that it is more prevalent and heavier in females of child-bearing age than in males of corresponding age, and that the greater bulk of the worm burden is concentrated in a small percentage of individuals, most of whom are children.

An analysis of the counts for trichuris showed that the parasite has practically the same age and sex distribution in a mixed population as ascaris, but the worm burden was more evenly distributed than in ascaris infestation.

A comparison of the three sets of count with each other showed no important differences in the intensity of ascaris in the three places where the survey was conducted, while in the case of trichuris the infestations were decidedly heavier in those from Pardo than in those from either Manila or Paombong. This difference in the distribution of the two parasites is ascribed to the difference in the resistance of their eggs. The ova of ascaris are resistant to many unfavorable external conditions, for which reason the parasite is very widely distributed. The ova of trichuris are easily destroyed by dessication, for which reason the danger of contracting heavy infestations with the parasite is greater in regions where, due to the distribution of the annual rainfall and the presence of covering vegetation, the ground is damp during the greater part of the year.

It was determined that ascaris infestation in the Philippines is due to soil pollution around the houses. In view of this, the high incidence and intensity of the parasite in Manila, where there is a modern system of waste disposal, is taken as an indication that not all of the members of the community utilize the available sanitary facilities. Observations made in some of the poorer and more crowded sections of the city, where the majority of the children examined reside, showed that it is the children of preschool age who are mainly responsible for the pollution of the soil. For this reason in any campaign against ascaris, in order to produce successful results, special efforts should be exerted to control the promiscuous defecation of children.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Bar diagrams showing average ascaris egg counts of Pardo series. See Table 1.

2. Bar diagrams showing average trichuris egg counts of Pardo series. See Table 5.

3. Bar diagrams comparing the egg counts for ascaris and trichuris of the Pardo series with those of the Manila and Paombong series.

4. Bar diagrams showing the monthly distribution of rainfall in Manila and Cebu. (From Coronas in the 1918 Census of the Philippine Islands.)

NEMATODES IN THE COLLECTION OF THE PHILIPPINE BUREAU OF SCIENCE, II: FILARIOIDEA

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FOUR PLATES

The nematode superfamily Filarioidea comprises an interesting group of parasites, of which the following species have already been reported from the Philippines: *Wuchereria bancrofti* of man, *Dirofilaria immitis* of dogs, *Setaria equina* of horses, *S. labiato-papillosa* of cattle, *Elæophora poeli* of cattle and carabaos, and *Diplotriæna corrugata* of the bird *Ptilocichla basilanica*. In the present paper are described six new members of the group, one of which was collected from cattle and the rest from birds. I wish to thank Dr. Zacarias de Jesus, of the Philippine Bureau of Animal Industry, for presenting the parasite from cattle, and Miss Victoria A. Masiluñgan, of the Bureau of Science, for much technical assistance.

Family FILARIIDÆ (Cobbold, 1864) Claus, 1885

Subfamily FILARIINÆ Stiles, 1907

PARAFILARIA BOVICOLA sp. nov. Plate 1, figs. 1 to 3.

Several specimens of this filaria were collected by Doctor Zacarias de Jesus, of the Bureau of Animal Industry, from native cattle presenting skin lesions that answer the description of those reported in horses and which are associated with a parasite very closely related to *Parafilaria multipapillosa* (Condamine and Drouilly, 1878). Only two of the specimens are complete for purposes of description and both are females. Doctor de Jesus, who is interested in the parasite from the pathological standpoint, has under observation an infested animal; if he should succeed in recovering male worms, a more complete description of the nematode than is given below will be forthcoming.

A comparison of the material at hand with the female of *Parafilaria multipapillosa*, as described by Railliet and Moussu (1892) and as figured by Yorke and Maplestone (1926), has

brought out the following differences: the eggs of the Philippine species as well as the inclosed embryos are smaller and the cuticular adornment at its anterior end appears quite distinct in that the papillalike structures behind the mouth that are characteristically numerous in *P. multipapillosa* are limited in number, there being more transverse cuticular prominences or ridges.

Specific diagnosis.—Parafilaria: Male unknown.

Female: Body whitish, 40 to 50 millimeters in length by 0.40 millimeter in maximum diameter. Anterior extremity conical, adorned for the most part with prominent, transverse, cuticular ridges interrupted at irregular intervals, and at its tip with a limited number of small roundish tubercles or papillalike structures; the rest of the cuticle is distinctly striated, the striations being 3.5 to 4 microns apart.

Mouth small, with two inconspicuous lateral lips and surrounded by four small papillæ, of which one pair is lateral and the other median. Œsophagus weak, 0.23 to 0.25 millimeter long, communicating with mouth through a short narrow vestibule; intestine prominent, its posterior end including anus atrophied. Nerve ring at or very near middle of œsophageal length. Cervical papillæ inconspicuous, behind level of œsophagus, 0.28 to 0.30 millimeter from anterior end. Uteri convergent, meeting at level about 0.7 millimeter from anterior end to form the vagina. Vulva close to mouth, 54 to 56 microns from anterior end. Eggs very thin-shelled, embryonated, 40 to 52 by 27 to 33.2 microns in size; the inclosed larvæ are provided with a short taillike process and are 160 to 190 by 5 to 6 microns in size. Posterior end rounded, with a pair of minute papillæ, one on each side of subterminal anus.

Host.—Native cattle.

Location.—Skin nodules.

Locality.—Tanauan, Batangas, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 427.

Subfamily DIPLOTRIÆNINÆ Skrjabin, 1916

DIPLOTRIÆNA PYCNONOTI sp. nov. Plate 2, figs. 1 and 2.

The material available for description consists of one male and four female worms collected from *Pycnonotus goiavier.* The parasite appears to be very closely related to *Diplotriæna corrugata,* a Philippine species reported by Wehr (1930) from the body cavity of the bird *Ptilocichla basilanica.* It differs

from the latter, however, as well as from the other members of the genus *Diplotriæna* by the number and arrangement of its genital papillæ. In *D. corrugata* there are, according to Wehr, seven or eight papillæ near the tip of the posterior end of the body, while in the species under consideration there are definitely three pairs of ventral postanal papillæ.

Specific diagnosis.—Diplotriæna: Body cylindrical, tapering towards both extremities which, however, are rounded. Cuticle transversely striated in both sexes. Mouth a simple opening without lips, surrounded by two lateral and four submedian papillæ. Œsophagus very long, inconspicuously divided into a short anterior and a long posterior portion and carrying at its anterior extremity a pair of lateral chitinous structures or tridents. Teeth of tridents with transverse external corrugations, at least on distal two-thirds of their lengths; they often vary in length, the middle one of a set usually shorter. Nerve ring immediately in front of junction of anterior and posterior portions of œsophagus.

Male: Length 22 millimeters, maximum diameter 0.5 millimeter. Œsophagus 3.10 millimeters in total length, its anterior portion 0.35 millimeter long. Tridents 0.14 millimeter long. Nerve ring 0.25 millimeter from anterior end of body. Cloacal opening 0.11 millimeter from posterior end which is rounded and without lateral wings. Genital papillæ three pairs, all postanal, ventral, and provided with short peduncles. Spicules unequal: right spicule characteristically twisted at proximal and distal thirds of its length and measuring 0.55 millimeter in length by 45 microns in maximum diameter across its proximal end; left spicule slightly bent but not twisted, more pointed distally than its fellow, and measuring 0.78 millimeter in length by 60 microns in maximum diameter across its proximal end.

Female: Length 30 to 48 millimeters by 0.60 to 0.72 millimeter in maximum diameter. Œsophagus 3.4 to 4.0 millimeters in total length, its anterior portion 0.36 to 0.40 millimeter long. Tridents 0.17 to 0.19 millimeter long. Nerve ring 0.30 to 0.34 millimeter from anterior end. Vulva much behind junction of two œsophageal regions, 0.54 to 0.78 millimeter from anterior end. Eggs moderately thick-shelled, embryonated when ready to pass out of body, 45.7 to 47.8 by 31.2 to 33.2 microns in size.

Host.—Pycnonotus goiavier.

Location.—Subcutaneous tissue (below crop).

Locality.—Sipocot, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 411.

Subfamily SETARIINÆ Yorke and Maplestone, 1926

SERRATOSPICULUM THORACIS sp. nov. Plate 1, fig. 4; Plate 3, figs. 1 to 4.

According to the arrangement of their genital papillæ, the known members of the genus *Serratospiculum* Skrjabin, 1916, may be conveniently divided into two groups as follows: (*a*) those possessing at least five and (*b*) those with less than five preanal genital papillæ. To the first group belong *S. turkestanicum* Skrjabin 1916, *S. helicinum* (Molin, 1858) Walton, 1927, and *S. chungi* Hoeppli and Hsü, 1929; and to the second group *S. tendo* (Nitzch, 1857) and *S. guttatum* (Schneider, 1866), as described by Seurat (1915). The parasite in question, which is represented by two males and six females, is affiliated with the two latter species, differing from them in the greater size of its body and the length of its spicules.

Specific diagnosis.—Serratospiculum: Body elongate, bluntly conical anteriorly and more or less rounded posteriorly in both sexes. Caudal extremity of female straight, that of male curved ventrally and provided with short lateral wings. Mouth elongate dorsoventrally, with two insignificant lateral lips, each supported by a small epauletlike structure, subdivided into three areas each connected with a papilla. There are in addition two other papillæ on each side so that there are in all five pairs of mouth papillæ, the arrangement of which is shown in Plate 3, fig. 2. Œsophagus divided into a short, narrow anterior part and a long, broad posterior part which gradually tapers posteriorly. Nerve ring near middle of length of anterior portion of œsophagus. Cervical papillæ 0.28 to 0.30 and excretory pore 0.32 to 0.35 millimeter from anterior end.

Male: Length 150 to 160 millimeters, maximum diameter 0.46 to 0.58 millimeter. Œsophagus 11.3 to 14.5 millimeters in total length, its narrow anterior part about 0.4 millimeter long. Testis coiled a number of times around junction of anterior and posterior portions of œsophagus. Cloacal opening 0.12 to 0.15 millimeter from posterior end. There are ten pairs of genital papillæ and a median unpaired papilla immediately anterior to cloacal opening. The paired papillæ are arranged as follows: four pairs preanal, of which two pairs are lateral and pedunculated, and two pairs ventral and sessile; six pairs postanal, of which three pairs are lateral and pedunculated and three pairs

ventral and sessile. The two spicules are very unequal: left spicule 1.1 to 1.3 millimeters long, transversely striated and swollen behind middle of its length with a maximum diameter of 0.16 millimeter, and jointed between anterior and middle thirds of its length; right spicule 0.48 to 0.50 millimeter long, its posterior half winged and distinctly serrated.

Female: Length 185 to 315 millimeters, maximum diameter 0.64 to 0.80 millimeter. Œsophagus 14.4 to 15.0 millimeters in total length, its narrow anterior portion 0.4 to 0.5 millimeter long. Vulva with prominent lips, 1.00 to 1.12 millimeters from anterior end. A well-developed ovejector present. Eggs moderately thick-shelled, those found in ovejector embryonated and measuring 50 to 54 by 33.2 microns. Anus posterosubterminal, about 50 microns from posterior end.

Host.—Falco ernesti.

Location.—Embedded in walls of thoracic and abdominal cavities.

Locality.—Manila, P. I.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 404.

HAMATOSPICULUM OTOMELARUM sp. nov. Plate 4, figs. 1 to 4.

This species is represented in the collection by four males and two females. Following the lead of Sandground (1933), it is assigned to the genus *Hamatospiculum* Skrjabin, 1916, in spite of the presence of a cephalic cap (epauletlike structure), for in other morphological characters it agrees with the description of that genus. Compared with the other members of the genus it appears to be most similar to *H. quadriens* (Molin, 1858), as described by Boulenger (1928), but differs from it in the length of its spicules and the number of its caudal papillæ.

Specific diagnosis.—Hamatospiculum: Body cylindrical, tapering toward both extremities. Anterior end in both sexes rounded. Cuticle faintly striated transversely. Mouth a simple terminal opening bounded laterally by a pair of toothlike structures and five pairs of papillæ which in their arrangement have the appearance of an epauletlike structure (Plate 4, fig. 2). Œsophagus divided into a short anterior portion and a long posterior portion. Nerve ring across middle of anterior portion of œsophagus or immediately anterior to that level.

Male: 25 to 27 millimeters long by 0.50 to 0.54 millimeter in maximum diameter. Œsophagus 6.2 to 6.5 millimeters in total

length, its anterior portion 0.28 to 0.30 millimeter long. Posterior end rounded, with narrow alæ meeting posteriorly. Spicules very unequal; right spicule 0.33 to 0.37 millimeter in length by 29 microns in maximum width at proximal end; left spicule filiform, 2.95 to 3.15 millimeters by 33.3 microns in size. Genital papillæ six pairs, with very short peduncles and arranged as follows: four pairs preanal and ventral and two pairs postanal and lateral. Cloacal opening about 80 microns from posterior end.

Female: 82 to 90 millimeters long by 0.86 to 0.95 millimeter in maximum diameter. Œsophagus 9 to 11.2 millimeters in total length, its anterior portion 0.38 to 0.44 millimeter long. Vulva with prominent lips, 1.10 to 1.35 millimeters from anterior end. Anus about 80 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be deposited, 52 to 56 by 33.2 to 35.6 microns in size.

Host.—*Otomela lucionensis.*

Location.—Under skin of head and neck and between trachea and œsophagus.

Locality.—Baao, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 428.

HAMATOSPICULUM LETICIÆ sp. nov. Plate 2, fig. 4.

This species is represented in the collection by two males and two females, one of which is badly damaged and therefore unfit for description. It is distinguished from *Hamatospiculum otomelarum* by its genital papillæ, of which there are five preanal pairs and three postanal pairs.

Specific diagnosis.—*Hamatospiculum:* Shape of body, structure of œsophagus, and arrangement of mouth papillæ as in *H. otomelarum.*

Male: 16 to 24.5 millimeters in length by 0.45 to 0.52 millimeter in maximum diameter. Total length of œsophagus 9.9 to 11.4 millimeters, its anterior portion 0.28 to 0.31 millimeter long. Posterior end rounded, with short narrow alæ meeting posteriorly. Spicules unequal: right spicule 0.265 to 0.300 millimeter in length by 25 microns in maximum width; left spicule 2.5 to 2.7 millimeters by 23 microns in size. Genital papillæ eight pairs, pedunculated and arranged as follows: five pairs preanal, and ventral; three pairs postanal, of which the second pair is ventral and the rest lateral. Cloacal opening about 50 microns from posterior end.

Female: 72 millimeters in length by 0.8 millimeter in maximum diameter. Total length of œsophagus 16.2 millimeters, its anterior portion 0.40 millimeter long. Vulva 1.0 millimeter from anterior end. Anus about 70 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be oviposited, 47 to 54 by 31.2 to 33.3 microns in size.

Host.—Halcyon chloris.

Location.—Under skin of head and neck.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 429.

HAMATOSPICULUM DICRURI sp. nov. Plate 2, fig. 3.

This worm is represented in the collection by three males and five females. It differs from the preceding two species as well as from the other members of the genus *Hamatospiculum* in being smaller and in the number of its genital papillæ.

Specific diagnosis.—Hamatospiculum: Shape of body, structure of œsophagus, and arrangement of mouth papillæ as in the two preceding species.

Male: 22 to 25 millimeters in length by 0.5 to 0.7 millimeter in maximum diameter. Œsophagus 5.5 to 7.3 millimeters in total length, its anterior portion 0.29 to 0.32 millimeter long. Posterior end rounded with poorly developed alæ. Spicules unequal: right spicule 0.32 to 0.38 millimeter in length by 23 to 25 microns in maximum diameter; left spicule 2.4 to 2.9 millimeters by 25 to 29 microns in size. Genital papillæ nine pairs, pedunculated and arranged as follows: six pairs preanal and ventral; three pairs postanal, of which the first pair is ventral and the rest lateral. Cloacal opening 75 to 80 microns from posterior end.

Female: 38 to 54 millimeters in length by 0.60 to 0.85 millimeter in maximum diameter. Œsophagus 7.8 to 8.4 millimeters in total length, its thin anterior portion 0.32 millimeter long. Vulva with prominent lips, 0.92 to 1.00 millimeter from anterior end. Anus about 80 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be deposited, 52 to 57.5 by 31.2 to 33.2 microns in size.

Host.—Dicrurus balicassius.

Location.—Under the skin of head.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 430.

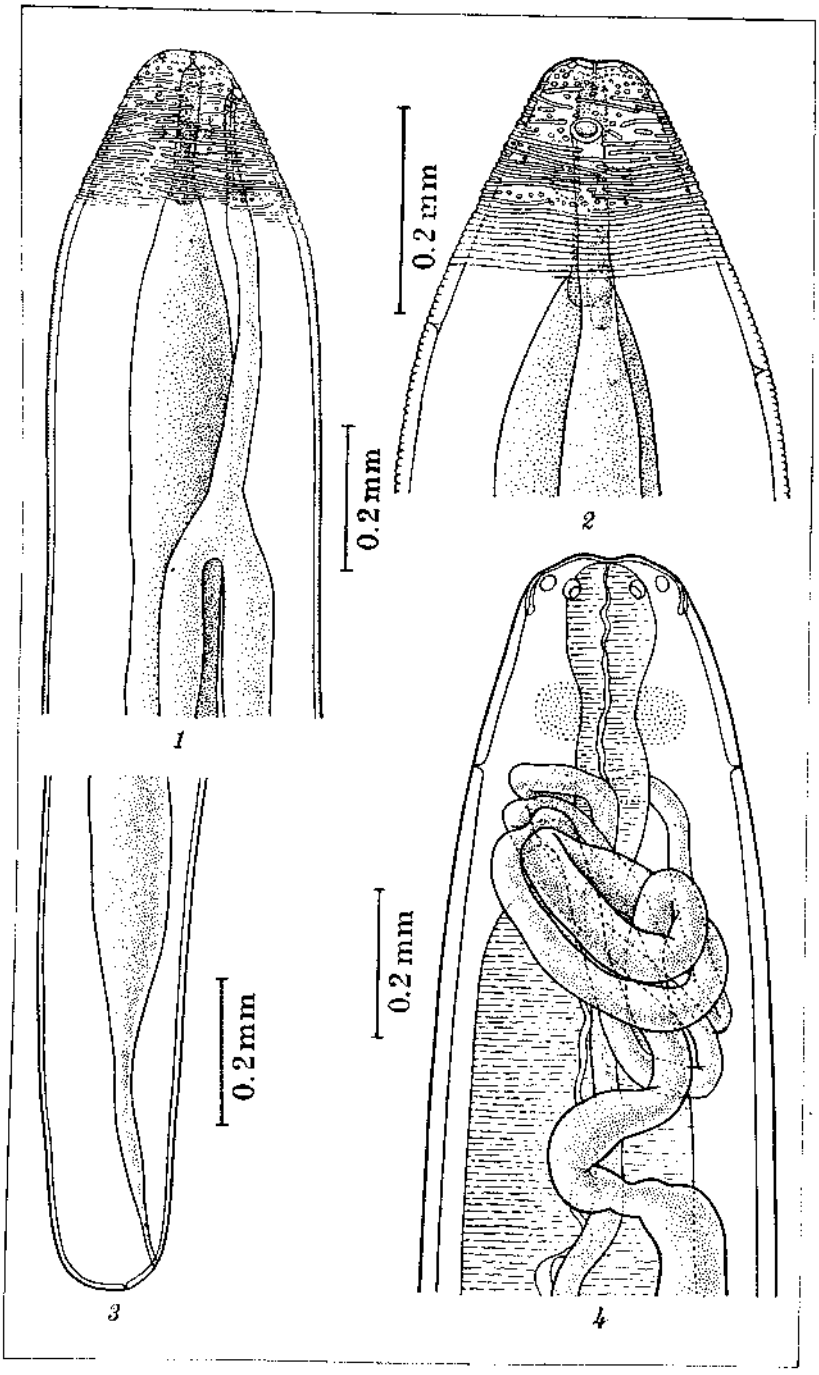

PLATE 1.

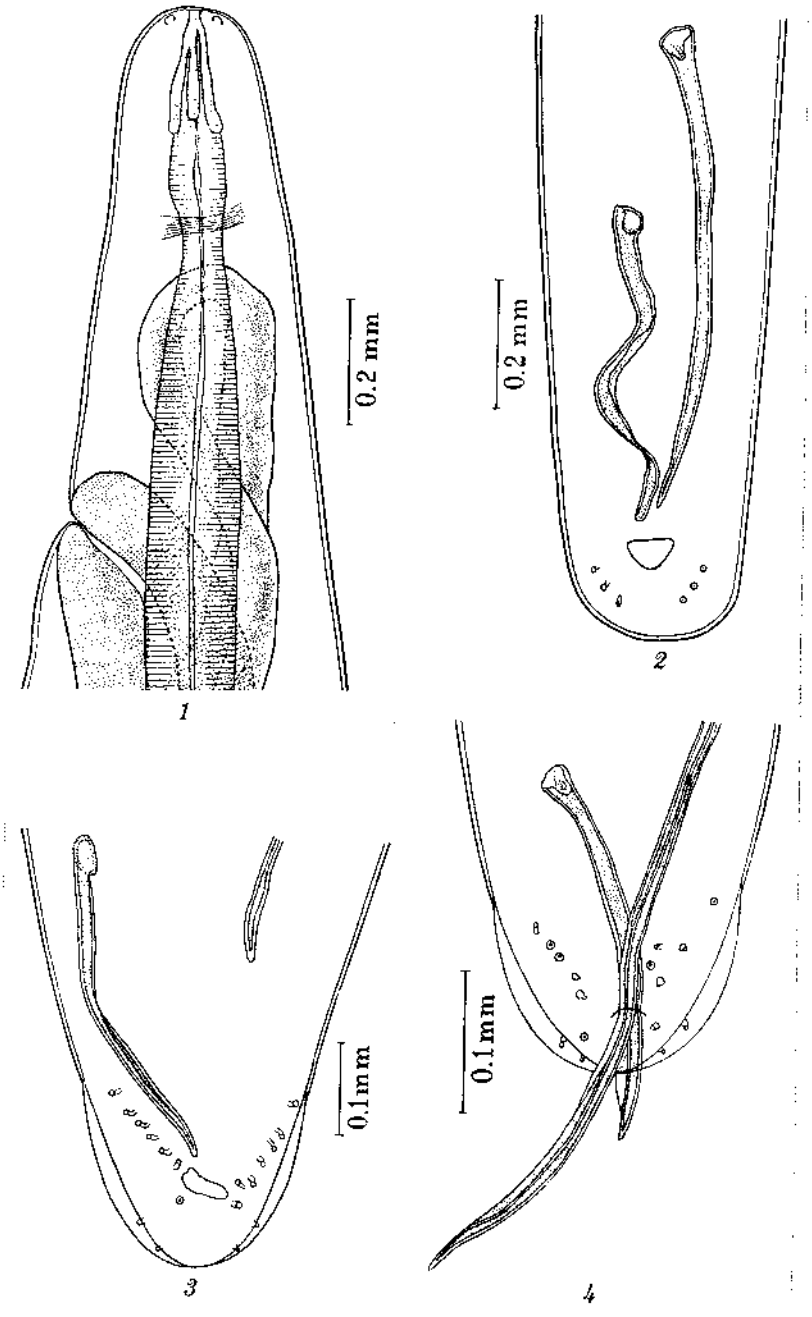

PLATE 2.

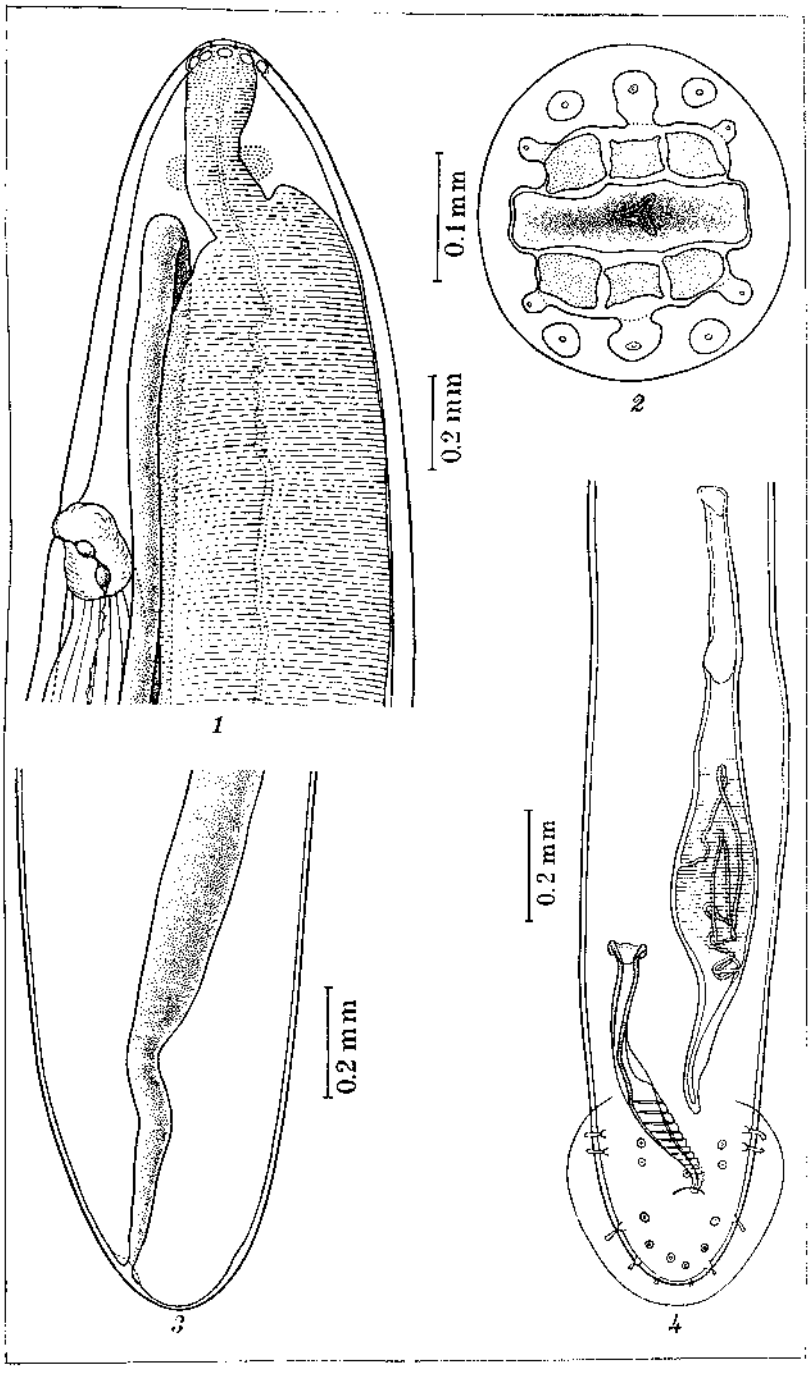

PLATE 3.

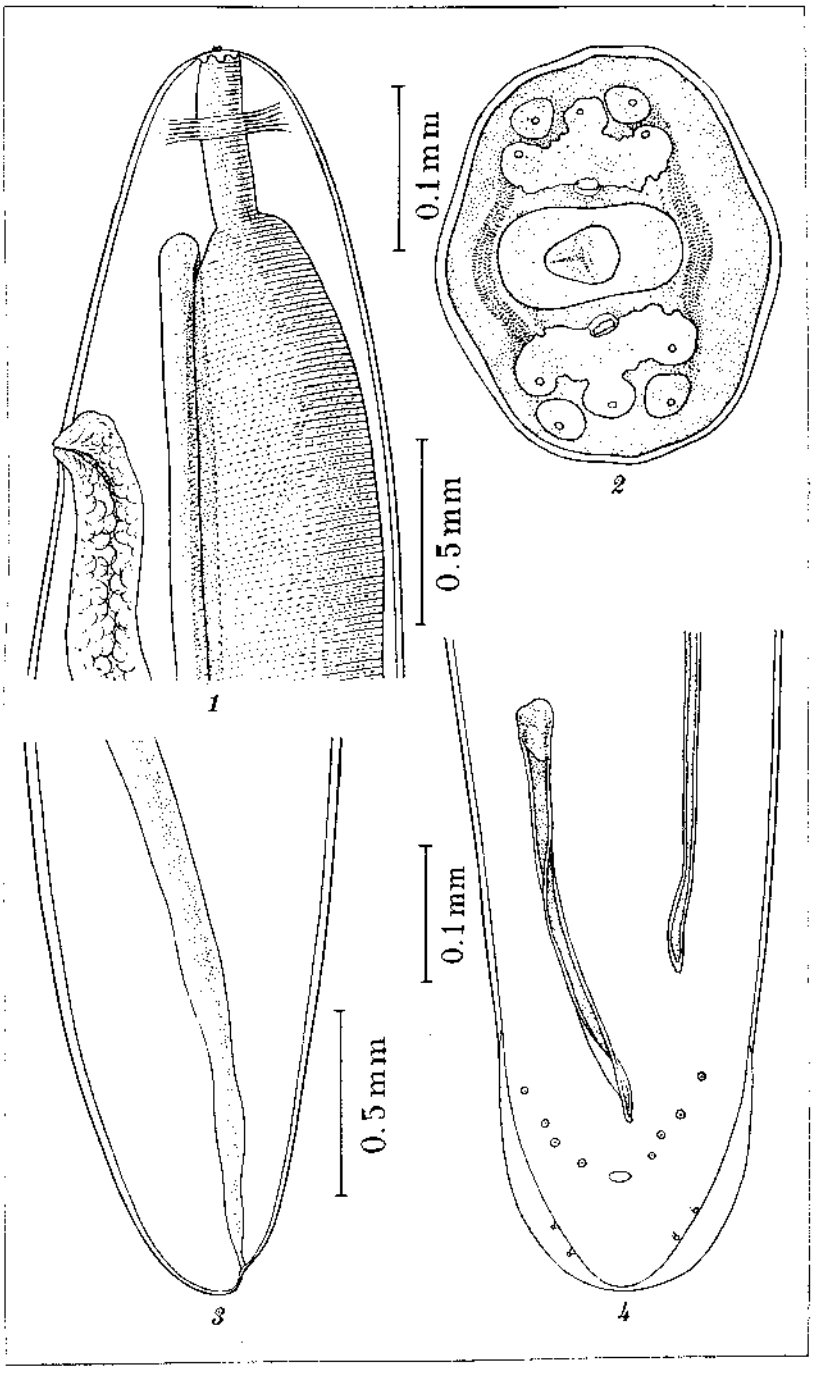

PLATE 4.

HÆMORRHAGIC FILARIASIS IN CATTLE CAUSED BY A NEW SPECIES OF PARAFILARIA[1]

By ZACARIAS DE JESUS

Of the Veterinary Research Division, Bureau of Animal Industry, Manila

ONE PLATE AND ONE TEXT FIGURE

INTRODUCTION

An unusual case of parasitism in cattle characterized by profuse local hæmorrhages from slightly raised nodules was discovered by the writer July 2, 1932, in Tanauan, Batangas, Philippine Islands.

The subject was a native bull (*Bos taurus*), ashey red in color, eight years old, and belonging to Miss Victorina Macaisa and her sisters. The animal has been raised and is used for plowing in Barrio Kale of the municipality of Tanauan. The owners as well as the tenant using this animal observed this condition for the first time in 1931.

A survey of the barrio of Kale April 28, 1933, revealed that four other cattle of both sexes, from two to five years old, were affected. A carabao, male, six years old, show the same symptoms, but no worm was recovered from two lesions. None of the horses raised in the same barrio and coming in contact with the infested cattle showed any symptom of this disease.

Railliet and Moussu (1922) report the occurrence of hæmorrhagic filariasis in the donkey. They point out that the parasite is lodged in the intermuscular, interfascicular, and subcutaneous connective tissue. These writers cite the reports of Sibal of its occurrence in horses of Tartaric origin, of Spinola and Leblanc in Russian horses, and of Bernard and Liautard in mules in Algeria. Drouilly, Trasbot, Mégnin, von Ratz, and others, according to Neumann (1910) and Hutyra and Marek (1926), observe hæmorrhagic filariasis in horses of Hungarian, Russian, and Tartaric origin.

Drouilly (1877) (Cited by Railliet and Moussu, 1892) reports the cause of hæmorrhagic filariasis in equines as *Filaria papillosa* [=*Parafilaria multipapillosa* (Condamine and Drouilly,

[1] Bureau of Animal Industry Technical Bulletin 6. Received for publication July 21, 1934.

1878)] (= *Filaria haemorrhagica* Railliet, 1885). Yorke and Maplestone (1926) and Baylis (1929) record only one species of *Parafilaria* from the horse tribe. According to Baylis (1929), *Parafilaria multipapillosa* is a parasite of the horse, donkey, and mule, and occurs chiefly in Oriental countries or in animals of Eastern origin. This writer states that it inhabits the subcutaneous and intermuscular connective tissue, and is the cause of a troublesome affection variously known as hæmorrhagic filariasis or parasitic dermatorrhagia.

There is no report, however, on the occurrence of this disease in cattle nor the collection of a species of *Parafilaria* from bovines. Hence, the present study here reported, which covered a period of two years, may be the first record of hæmorrhagic filariasis in cattle caused by another species of *Parafilaria*.

ETIOLOGY

The causal organism is a filaria belonging to the genus *Parafilaria* Yorke and Maplestone, 1926. The female has a whitish body measuring from 40 to 50 millimeters in length by 0.40 millimeter in maximum diameter. The eggs, which are very thin-shelled and are already embryonated when laid, are 40 to 52 by 27 to 33.2 microns in size. Several specimens of this parasite were submitted to Dr. Marcos A. Tubangui of the Philippine Bureau of Science who describes them in a preceeding paper in this issue of the Philippine Journal of Science as *Parafilaria bovicola*.

The females of this *Parafilaria* were found lodged in the nodules (fig. 1, *f*). No male specimen was recovered from the lesions. The locations of the males as well as the other locations of the females have not been determined for there has been no opportunity to post an infested animal. For this reason the complete pathology of the disease has also not yet been determined.

The life history and transmission of this parasite is not yet known. The writer has an infested bull under observation in an attempt to determine the mode of transmission as well as the life history of the parasite.

SYMPTOMS

The infested animals at first showed slightly raised nodules scattered on the different parts of the body and neck. The nodules were irregular, and were from 5 to 7 millimeters thick and from 15 to 25 millimeters in diameter at the base. As a

rule these nodules were not painful on palpation. They were tough and the skin covering them was thickened. But the involved skin at this stage of the disease did not show any sign of inflammation. The first symptoms generally appeared about the beginning of December.

Two to three weeks later some nodules began to bleed profusely and became enlarged and slightly raised, attaining a maximum diameter of 40 millimeters at the base and a maximum thickness of 10 millimeters (Plate 1, figs. 1 and 2 marked *b*). On palpation the bleeding nodules were painful and were as tough as the nonbleeding ones (*n*). At the highest point of a bleeding nodule there was a fistulous tract or opening extending through the skin, measuring about 1 millimeter in diameter, from which the blood oozed out (fig. 1, *e*). In one case the blood was actually seen dripping slowly in a tiny stream from a nodule on the back down across the side to the belly. Incision through the skin along the fistulous tract showed that the tissues immediately around the tract were highly inflamed with a thin layer of necrotic tissues lining the tract.

The hæmorrhage was more profuse in animals that were used for plowing or pulling carts and in those that grazed in the open on hot days. The bleeding was recurrent. In exceptional cases, however, the hæmorrhage took place during the hotter part of the day and subsided at night, and then recurred every day for three to five days. If not attended to, the bleeding stopped by itself, the fistulous tract becoming plugged with some coagulated blood. The hæmorrhage per se did not seem to affect the patient. But sometimes as many as seven nodules were bleeding profusely at the same time in which case the infested animal showed general debility. It had a pale mucous membrane indicating anemia, lost in weight, and its pulling power was much reduced.

One infested animal, 8 years old, male, and used for plowing, was examined at long intervals for the occurrence and the distribution of the nodules. The symptoms were seasonal in their occurrence and variable in their duration as shown in Table 1. The distribution of the nodules was also variable. They were generally manifested by the infested animals during the period from the latter part of December to the middle part of July. Then all the nodules disappeared completely. At other times, the disease, in all its stages, persisted even up to the middle of September.

TABLE 1.—*Showing the occurrence and distribution of the nodules.*

Date.	Non-bleeding nodules.	Bleeding nodules.	Location.
July 2, 1932	4	7	Neck, withers, shoulders, and back.
July 16, 1932	7	3	Neck, withers, shoulders, back, and thigh.
April 28, 1933	3	1	Neck and shoulders.
May 15, 1933	4	5	Neck, shoulders, and back.
September 7, 1933	3	0	Neck and shoulders.
October 9, 1933	0	0	
November 13, 1933	0	0	
December 29, 1933	2	1	Neck and shoulders.
February 27, 1934	3	2	Neck, shoulders, and back.

DIAGNOSIS

Hæmorrhagic filariasis in cattle was diagnosed by the presence of the characteristic symptoms and the recovery of the *Parafilaria* from the nodules. Incipient cases were difficult to diagnose due to the absence of profuse local hæmorrhages which were pathognomonic of the disease. It had been observed that the worms were not present in nonbleeding nodules. In advanced cases the characteristic local hæmorrhages from the

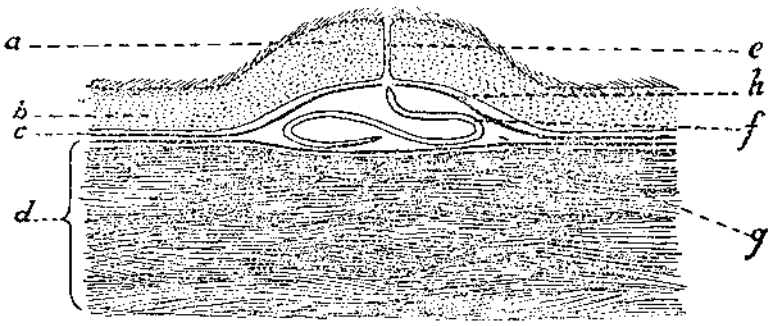

FIG. 1. A schematic drawing showing the cross section of a nodule with a *Parafilaria* in situ.

apices of the nodules were very prominent and the parasite could be recovered from the bleeding nodule.

This *Parafilaria* could be removed intra vitam from the nodules only by surgical means. For the sake of clarity the worm in situ is shown in a schematic drawing (fig. 1). By making an incision, 4 to 5 centimeters long, through the skin, a small fascicular fold (fig. 1, *h*) 2.5 centimeters in diameter, can be seen just beneath the skin. After cutting open the wall of the

TABLE 2.—*Showing the results of the examinations of the nodules for Parafilaria.*

Date.	Nonbleeding.		Bleeding.		Worms in each nodule.
	Number.	Positive.	Number.	Positive.	
July 2, 1932	1	0	2	1	One female.
July 16, 1932	0	0	2	2	Do.
April 28, 1933	8	0	1	0	None.
May 15, 1933	0	0	3	2	One female.
September 7, 1933	2	0	0	0	None.
December 29, 1933	1	0	2	1	One female.
February 27, 1934	0	0	1	1	Do.

sac or cyst, the worm (*f*) comes out with a little amount of seropurulent fluid. Only female worms were collected by this method. Just where the younger females as well as the males are lodged in the body of the host has not yet been determined.

The bleeding and nonbleeding nodules of some infested cattle were examined surgically for the presence of *Parafilaria*. The results are shown in Table 2. Deep skin scrapings from each of three bleeding and three nonbleeding nodules as well as the blood from the ear vein of each of three cattle were examined twice for *Microfilaria*. All the samples were negative. Several microscopic examinations of the blood oozing out from ten nodules were also negative. It is highly probable, however, that either the embryonated eggs or the larvæ may be found coming out of the nodules with the blood at a certain stage of the hæmorrhage. Hence, further investigation is being conducted to determine this point.

In the pre-bleeding stage of the disease the nodules may be confused with those of urticaria and insect bites. In the advanced stage the bleeding nodules may be mistaken for the lesions in skin myiasis. In myiasis, however, there is hardly any swelling of the affected parts, and on palpation the skin sinks and a sanguinous pus, which fills the cavity under the skin, oozes out. The opening is much larger and irregular in myiasis, and in most cases the maggots can be recovered from the cavities.

SUMMARY

1. Hæmorrhagic filariasis in cattle, which occurs in Tanauan, Batangas, Philippine Islands, and is characterized by profuse local hæmorrhages from slightly raised nodules, is hereby reported possibly for the first time.

2. This filariasis is caused by a new species of filaria (*Parafilaria bovicola*).

3. Only mature females were found in the bleeding nodules, and no specimens were found in the nonbleeding ones.

4. The occurrence of the disease is seasonal and its duration variable.

5. While the disease is benign, heavily infested animals, on account of general debility as a sequel, are predisposed to more dangerous microbian diseases.

6. This species of *Parafilaria* is apparently not transmissible to horses.

7. While no parasites were found in the bleeding nodules of a carabao presenting symptoms very similar to those manifested by infested cattle, there is reason to suppose that carabaos are susceptible to this parasitic disease.

ACKNOWLEDGMENT

The writer is indebted to the College of Veterinary Science for the facilities afforded him in conducting this investigation while still in Los Baños. Thanks are due Dr. Teodulo Topacio, chief of the Veterinary Research Division, for his valuable suggestions, and Miss Victorina Macaisa and her sisters for kindly allowing the writer to conduct this investigation on their farm.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A bull suffering from hæmorrhagic filariasis, showing nodules.

2. A close-up of a portion of the body of the same animal showing bleeding (*b*) and nonbleeding (*n*) nodules.

(Photographed by the author. Enlarged by the Division of Publications, Department of Agriculture and Commerce.)

TEXT FIGURE 1. A schematic drawing showing the cross section of a nodule with a *Parafilaria* in situ.

a. Indurated skin over the nodule.
b. Normal skin.
c. Fascia.
d. Muscles.
e. Fistulous tract.
f. Parafilaria.
g. Fascicular sac or cyst.
h. Fold of fascia.

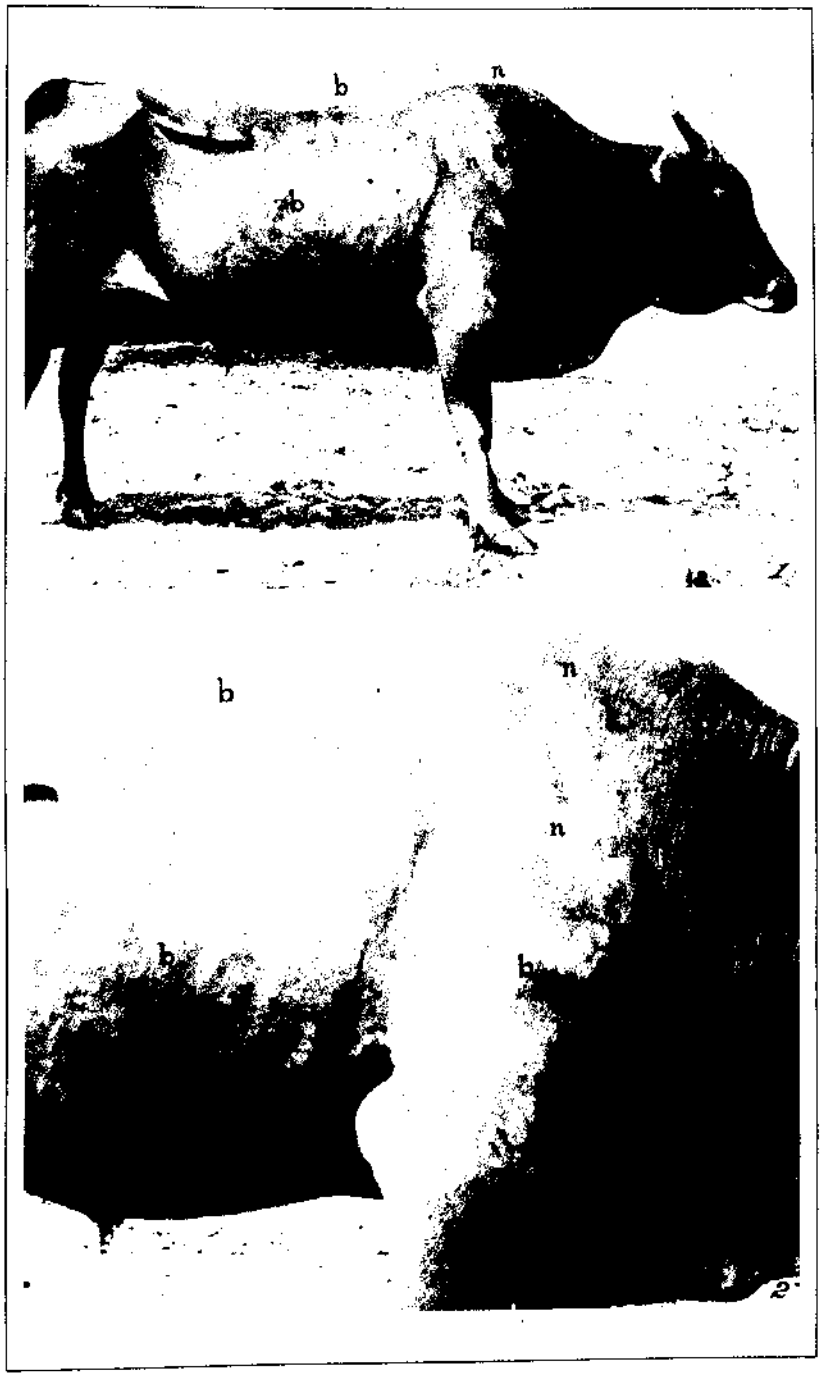

PLATE 1.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXII [1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The crane flies discussed herewith are chiefly from Celebes Island, where they were collected by my friend and colleague Mr. Charles F. Clagg. A further considerable series of species are from Formosa where they were secured by Messrs. Esaki, Gressitt, and Issiki. One further species is from Korea where it was taken by Professor Masaki. The Esaki material has been returned to Professor Esaki for incorporation in the collection of the zoölogical laboratory, Kiushiu Imperial University; all other species are preserved in my own extensive series of these flies through the friendly interest of the various collectors.

TIPULINÆ

TIPULA (LUNATIPULA) MULTIBARBATA sp. nov. Plate 1, fig. 1; Plate 2, figs. 25, 26.

Belongs to the *marmoratipennis* group; antennæ weakly bicolorous, the bases of the flagellar segments narrowly pale; præscutal stripes four in number, gray, narrowly bordered by brown; femora yellow, the tips narrowly brownish black; wings creamy white, heavily marmorate with pale brown and darker brown clouds; male hypopygium with conspicuous brushes of long yellow setæ on the tergite and on the eighth sternite, the latter sclerite extensive but not extended far caudad into a boat-shaped structure, as is the case in certain other species of the group.

Male.—Length, about 15 millimeters; wing, 21.

Frontal prolongation of head brownish, the long strong nasus chiefly yellow; palpi yellow, the outer segments somewhat darker. Antennæ of moderate length, if bent backward extending to some distance beyond wing root; scape and pedicel yellow; flagellar segments dark brown, the extreme proximal ends of the basal enlargements yellow, to produce a weak bicolorous ap-

[1] Contribution from the entomological laboratory, Massachusetts State College.

pearance; longest verticils subequal to the segments; last flagellar segment approximately one-half as long as the penultimate. Head light ashy gray, the center of vertex extensively cinnamon-brown, with a further dark brown, capillary, median vitta.

Mesonotal præscutum light gray, with four distinctly separated, darker gray stripes that are narrowly bordered by brown; scutal lobes gray, with darker gray central areas; posterior sclerites of notum gray, with a capillary brown median vitta. Pleura gray, the dorsopleural region rather light brown. Halteres yellow, the base of knob brown, the apex yellowish. Legs with the coxæ yellowish, sparsely pruinose; trochanters yellow; femora yellow, the tips narrowly brownish black, somewhat lighter on the flexor surface; tibiæ brownish yellow, the tips narrowly and rather weakly infuscated; tarsi passing into brownish black. Wings (Plate 1, fig. 1) with the ground color whitish cream, variegated with pale brown and darker brown, the general appearance being rather heavily marmorate; cell Sc uniform yellow, contrasting with the whitish cell C; post-arcular darkening in bases of cells R and M restricted; stigma brown, its central portion more yellow; the darkened clouds leave a narrow oblique band of the ground color extending from behind origin of Rs to the wing margin in cell 1st A; veins brown. Macrotrichia of veins relatively small and weak, on R_3 restricted to two or three near outer end of vein; squama with about sixteen to eighteen strong black setæ. Venation: Free tip of Sc_2 far before R_{1+2}, so cell Sc_2 at costa is unusually extensive; Rs elongate, exceeding twice m-cu; vein R_3 rather strongly arcuated, slightly narrowing cell R_3 at near midlength; cell 1st M_2 relatively long, m being much longer than the basal section of M_{1+2}; m-cu at fork of M_{3+4}.

Abdominal tergites one to five light grayish yellow, each with an interrupted brown median dash, the lateral borders of tergites one to two narrowly dark brown; lateral borders of tergites narrowly silvery gray, increasing in area on the outer segments; sixth and succeeding tergites passing into brownish black; sternites with basal five segments yellow, the outer ones darker. Male hypopygium (Plate 2, fig. 25) with the ninth tergite, 9*t*, fused with the sternite, 9*s*, on posterior half; basistyle and the small sternite entirely fused. Ninth tergite (Plate 2, fig. 25, 9*t*) narrow, constricted by pale membrane on cephalic portion; caudal margin with a median and two lateral lobes that are densely set with short blackened setæ; behind or ce-

phalad of these three cushions, on either side of midline, a transverse group of long conspicuous erect yellow setæ; viewed laterally, the median black cushion is seen to lie farther cephalad than the more-projecting lateral pair. Outer dististyle broad on basal half, the outer half more narrowed, the inner face set with small black spines, of which the outer two or three are larger and more conspicuous. Inner dististyle, *id*, about as shown, the outer angle a powerful black spine; viewed separately and in a flattened condition, the style appears conspicuously bilobed on inner margin, with a deep U-shaped emargination separating the lobes. Eighth sternite (Plate 2, fig. 26, 8*s*) very extensive, sheathing, the lateral edges extending high up over the sides of the ninth sternite, the outer lateral angles produced into pale bulbous lobes that are set with abundant long pale setæ; median area of sternite truncate, with a transverse row of long yellow setæ.

Habitat.—Korea.

Holotype, male, Shorei, July 9, 1923 (*J. Masaki*).

The *marmoratipennis* group includes, besides the typical form and the present fly, three Japanese species, *holoteles* Alexander, *naviculifer* Alexander, and *shogun* Alexander, that are among the most beautiful and conspicuous of all Japanese species of *Tipula*. The group is best distinguished by the short, fleshy valves of the ovipositor, and by certain venational details, as the unusually long Rs and the more or less arcuated vein R_3, which tends to narrow cell R_3. I have been privileged to study both the type and paratype of *marmoratipennis* Brunetti (holotype, female, Darjiling, altitude 7,000 feet, May, 1910—not "April" as stated by Brunetti—paratype, female, Darjiling, August 7, 1909), through the friendly interest of the authorities of the Indian Museum.

The present fly is very different from the other Japanese species listed above. The male hypopygium is quite distinct, notably the eighth sternite, which, while very extensive and sheathing, yet is not at all narrowed into a boat-shaped median lobe as in the other species (male sex not yet known in *holoteles*).

DOLICHOPEZA (NESOPEZA) TOALA sp. nov. Plate 1, fig. 2; Plate 2, fig. 27.

Belongs to the *costalis* group; mesonotal præscutum dark cinnamon-brown; pleura almost uniformly dark brown, only the ventral pteropleurite restrictedly paler; legs with the femora obscure yellow, the tips weakly darkened; tibiæ dirty brown; tarsi snowy white; wings with the ground color rather strongly

infumed; cell M_1 subequal to or shorter than its petiole; male hypopygium with the median area of tergite produced into a low triangular point; eighth sternite with the median area slightly produced and provided with pale yellow setæ.

Male.—Length, about 8.5 to 9 millimeters; wing, 10 to 10.5.

Female.—Length, about 11 millimeters; wing, 11.

Rostrum and palpi dark brown. Antennæ with the scape and pedicel light brown; first segment of flagellum obscure yellow, the outer segments dark brown; flagellar segments cylindrical, with short inconspicuous verticils. Head with the front and anterior vertex cinnamon-brown, the posterior vertex and occiput darker brown.

Mesonotal præscutum and scutum dark cinnamon-brown; scutellum and mediotergite a little darker brown. Pleura dark brown, only the ventral pteropleurite restrictedly paler. Halteres pale, the knobs dark brown. Legs with the fore and middle coxæ dark brown, the posterior coxæ more testaceous; trochanters yellow; femora obscure yellow, the tips weakly darkened; tibiæ dirty brown, the extreme base more whitened; tarsi snowy white (fore and hind legs broken). Wings (Plate 1, fig. 2) with the ground color rather strongly infumed; the usual dark costal pattern of the *costalis* group is present, the areas not margined by paler; cell R_3 with brown clouds on outer portion, including a band at two-thirds the length; cell Cu darkened; veins dark brown. Venation: Rs elongate and spurred, as in group; medial forks short, cell M_1 subequal to or shorter than its petiole; cell 2d A relatively wide.

Abdomen with basal segments chiefly obscure yellow, beyond the second chiefly dark brown, especially medially and at outer ends. Male hypopygium (Plate 2, fig. 27) with the median area of tergite, 9*t*, produced into a low triangular point. Eighth sternite, 8*s*, with the median area slightly produced and provided with pale yellow setæ, some of which are decussate at midline.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 2 males.

The specific name is that of an aboriginal tribe of Celebes. The only allied species is *Dolichopeza* (*Nesopeza*) *borneensis* (Edwards), of North Borneo, which differs in the coloration of the wings and the uniformly pale thoracic pleura. This latter

species has Rs with a longer basal spur and lying closer to R_1 than is the case in the present fly.

DOLICHOPEZA (NESOPEZA) PROFUNDEMARGINATA sp. nov. Plate 1, fig. 3; Plate 2, fig. 28.

Belongs to the *costalis* group; most nearly allied to *geniculata;* basal segments of flagellum pale; pleura brown, the dorsopleural region and pteropleurite whitish; male hypopygium with median area of tergite unequally trilobed, separated from the slender lateral arms by narrow incisions; eighth sternite long and sheathing, profoundly emarginate medially, each lateral lobe obtusely rounded.

Male.—Length, about 8 millimeters; wing, 9.2.

Female.—Length, about 10 millimeters; wing, 9.

Rostrum dark brown; palpi brown, especially the outer segment. Antennæ with scape dark brown, pedicel a trifle paler; flagellum with basal segments white, the outer ones passing into pale brown; flagellar segments cylindrical, with verticils that are shorter than the segments. Head pale brown.

Mesonotum brown, the præscutal stripes scarcely demarked. Pleura brown, the dorsopleural region and pteropleurite whitish. Halteres white, the knobs dark brown. Legs with the coxæ dark brown, the posterior pair paler on basal portions; trochanters pale yellow; femora pale yellow, the tips broadly and conspicuously black, preceded by a narrow, more whitish ring; tibiæ dirty white, the tips narrowly blackened, preceded by a clearer ring; tarsi snowy white. Wings (Plate 1, fig. 3) with the ground color grayish, with the usual dark brown pattern of the group, the costal areas narrowly bordered behind by whitish; isolated white spots in outer ends of cells R_3 and R_5; small white spots at h and arculus; veins chiefly pale brown, the cord and elements lying in the dark markings brown. Venation: Basal spur of Rs elongate; forks of medial field short.

Abdominal tergites dark brown, the lateral portions of the second tergite restrictedly pale; succeeding tergites variegated beyond base with obscure yellow. Male hypopygium with the ninth tergite (Plate 2, fig. 28, 9*t*) having the median area protuberant, unequally trilobed, separated from the lateral portions by a notch; lateral arms relatively slender, with several small wartlike points. Eighth sternite, 8*s*, large and sheathing, profoundly emarginate medially, forming two short cylindrical lobes with blunt tips; at base of notch, on either side, with a small lobule; median region of sternite cephalad of base of emargination with pale membrane almost to border of sclerite.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude about 1,500 feet, April 1, 1932 (*Gressitt*). Allotype, female, Giran, November 20, 1928 (*Issiki*).

Dolichopeza (*Nesopeza*) *profundemarginata* is very similar to *D.* (*N.*) *geniculata* Alexander (Japan) in all colorational features, differing notably in the structure of the male hypopygium, especially the long, sheathing sternite that is deeply emarginate.

DOLICHOPEZA (NESOPEZA) TORAJA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

Belongs to the *gracilis* group; wings tinged with brown, the usual darkened pattern of the group very poorly defined and not extending distad beyond the stigma; male hypopygium with median region of tergite only slightly convex; eighth sternite unarmed.

Male.—Length, about 8 millimeters; wing, 8.8.

Rostrum and palpi dark brown. Antennæ with scape dark brown, the succeeding segments paler brown; flagellar segments long-cylindrical, clothed with a short dense white pubescence and with short inconspicuous verticils. Head dark brown.

Mesonotal præscutum brown, with three brownish black stripes, the median one elongate, the laterals abbreviated; scutal lobes variegated with dark brown; scutellum brownish black; mediotergite brown. Pleura distorted in the unique type, apparently almost uniform brown. Halteres elongate, black, the base of stem restrictedly pale. Legs with the coxæ brownish; trochanters paler; remainder of legs broken. Wings (Plate 1, fig. 4) with the ground color weakly tinged with brown; the usual dark costal pattern of the group is here only faintly differentiated from the ground color, being indicated by a darkening at base, the costal region and the stigma, with further very restricted clouds at origin of Rs, anterior cord, and end of vein Cu_1; no darkening beyond stigma; veins dark brown. Venation: Rs elongate, angulated and long-spurred near origin; medial forks relatively deep.

Abdominal tergites weakly bicolorous, the basal half or more brownish yellow; posterior ring dark brown or brownish black. Male hypopygium (Plate 2, fig. 29) with the median region of tergite, 9*t*, almost transverse or only feebly elevated, narrowly blackened; lateral lobes of tergite obtuse. Inner dististyle, *id*, with the apical beak slender. Eighth sternite, 8*s*, with the caudal margin very gently convex, without special armature of lobes or setæ.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

The specific name is that of an aboriginal tribe inhabiting central, southeastern, and eastern Celebes. *Dolichopeza* (*Nesopeza*) *toraja* is very distinct from all other members of the *gracilis* group in the slightly infumed wings and scarcely differentiated dark costal pattern.

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) FALSA sp. nov. Plate 1, fig. 5; Plate 2, fig. 30.

Mesonotal præscutum shiny reddish, the posterior sclerites of mesonotum and the pleura variegated with dark brown or brownish black; antennæ black throughout, the flagellar segments with long verticils; halteres yellow, knobs brownish black; wings whitish subhyaline, prearcular region yellow; costal border of wings dark brown; free tip of Sc_2 lying far before level of R_2; m-cu opposite midlength of cell 1st M_2; anal veins convergent; abdominal tergites brownish black medially, pale laterally; male hypopygium with the rostral prolongation long and slender, with two small spines at base.

Male.—Length, about 7 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with elongate verticils that considerably exceed the segments. Head dark gray, the front and very narrow anterior vertex silvery.

Pronotum dark brown above, more yellowish on sides. Mesonotal præscutum shiny red, unmarked; scutum dark brown, the centers of the lobes more castaneous; scutellum testaceous-brown; mediotergite dark brown. Pleura with the propleura and ventral sternopleurite more yellowish; dorsal sternopleurite, anepisternum, and posterior pleural sclerites darker brown. Halteres yellow, the knobs brownish black. Legs with the coxæ and trochanters yellow; femora yellow basally, at near midlength becoming darker, at tips passing into brownish black; tibiæ brownish yellow, the tips narrowly darker; tarsi brownish yellow, the outer segments darker. Wings (Plate 1, fig. 5) whitish subhyaline; prearcular region light yellow; costal border, including cells C and Sc, dark brown, the color continued outward to wing tip; stigma very small, still darker brown; brown seams along vein Cu_1, on m-cu and in axillary region; veins dark brown,

luteous in the prearcular field. Macrotrichia of veins long and conspicuous. Venation: Sc_2 ending about opposite midlength of cell 1st M_2, Sc_2 longer than Sc_1; Rs elongate; free tip of Sc_2 far before level of R_2; R_1 with numerous trichia; R_{1+2} jutting beyond R_1 as a slight spur or thickening; outer radial veins moderately decurved at tips; m-cu at midlength of cell 1st M_2; vein 2d A converging strongly toward 1st A.

Abdominal tergites yellow, brownish black medially, forming a continuous median stripe that is a little expanded at the posterior borders of the segments; sternites yellow, segments eight and nine brownish black, the styli pale. Male hypopygium (Plate 2, fig. 30) with the tergite, 9*t*, broadly transverse, the caudal border convex. Ventral dististyle, *vd*, smaller in area than the basistyle; rostral prolongation long and slender, with two rostral spines close to its base; a pale lobe on face of style opposite base of prolongation (not shown in figure). Mesal-apical lobe of gonapophysis slender. Ædeagus, *a*, very broad.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Despite its small size and the unusual pattern of the wings, the present fly belongs to the typical section of the subgenus, having convergent anal veins and a hypopygium of the general structure of this group of species. In Edwards's key to the species of *Libnotes*[2] the fly runs to couplet 28, disagreeing with all species beyond by the wing pattern and venation of the radial field, especially the position of the free tip of Sc_2 some distance proximad of R_2.

LIMONIA (LIBNOTES) COMISSABUNDA sp. nov. Plate 1, fig. 6.

General coloration of mesonotum buffy, the præscutum vaguely lined with darker; antennæ black; femora yellow, with a brown subterminal ring; wings whitish subhyaline, with a restricted brown pattern, including seams along cord and outer end of cell 1st M_2; vein R_{2+3} strongly arcuated at proximal end; cell 1st M_2 elongate, widened at outer end, m-cu at near one-third its length; m gently arcuated, about twice the basal section of M_3; anal veins convergent at bases; ovipositor with cerci bidentate at tips.

Female.—Length, about 10 millimeters; wing, 12.

Rostrum and palpi brownish black. Antennæ brownish black; flagellar segments oval, the longest verticils about twice the seg-

[2] Journ. Fed. Malay St. Mus. 14 (1928) 74–80.

ments. Front and anterior vertex light golden yellow; posterior vertex grayish brown, the central portion more fulvous, with a further capillary dark line.

Pronotum buffy on sides and as a mid-dorsal vitta, the remainder of dorsum dark brown. Mesonotum buffy, vaguely lined with darker, including a pair of intermediate brown stripes; posterior sclerites of notum sparsely pruinose, the centers of the scutal lobes darker. Pleura pale, the propleura and ventral anepisternum weakly darkened. Halteres elongate, yellow, the knobs dark brown basally, the apices a little brightened. Legs with the fore coxæ a trifle darker than the others, middle and posterior coxæ yellow; trochanters yellow; femora yellow with a brown subterminal ring at about its own width before the tip; tibiæ light brown, the tips narrowly darkened, the outer tarsal segments darkened. Wings (Plate 1, fig. 6) whitish subhyaline, the prearcular and costal regions more yellow; a restricted brown pattern, appearing as seams to certain of the veins, including the cord and outer end of cell 1st M_2; basal half of R_{2+3} and adjoining portions of outer end of vein Sc; narrow stigmal area; outer third of 2d A; less distinct clouds at arculus and in axillary region; veins yellow, dark brown in the clouded areas. Venation: Sc long, Sc_1 ending beyond m-cu, Sc_2 at its tip; Rs gently arcuated; R_{2+3} strongly arcuated at proximal end, constricting cell R_1 at near one-third the length; R_3 decurved at outer end; free tip of Sc_2 and R_2 in approximate transverse alignment; cell 1st M_2 elongate, widened at outer end; m gently arcuated, about twice the basal section of M_3; m-cu at just before one-third the length of cell 1st M_2; anal veins convergent at bases.

Abdominal tergites variegated with dark brown and obscure yellow, the ground color dark, the caudal borders more yellow; sternites with the pattern similar but less contrasted. Ovipositor with the cerci bidentate at tips.

Habitat.—Formosa (north).

Holotype, female, Taiheizan, May 6, 1932 (*Gressit*).

In Edwards's key to the species of *Libnotes* [3] the present fly runs to *Limonia* (*Libnotes*) *nohirai* (Alexander), which differs notably in the broadly blackened tips of the femora and in the details of venation. In its general appearance the species also suggests species such as *L.* (*L.*) *amatrix* (Alexander), but differs

[3] Loc. cit.

conspicuously in the pattern of the legs and wings, and in the venation.

LIMONIA (LIMONIA) ALOPECURA sp. nov. Plate 1, fig. 7; Plate 2, fig. 31.

Belongs to the *pendleburyi* group; coloration almost uniformly pale testaceous-brown to reddish brown; antennæ relatively long; wings whitish subhyaline, the stigma conspicuous, dark brown; cell 1st M_2 large, exceeding the veins beyond it; male hypopygium unusually complex in structure, the basistyle bearing three distinct lobes and outgrowths on mesal face.

Male.—Length, about 5 millimeters; wing, 6.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi brown. Antennæ relatively long; scape and pedicel dark brown, flagellum paler, testaceous-brown; flagellum moniliform, the segments strongly constricted at outer ends into short pedicels; terminal segment longer than the penultimate, strongly pointed at outer end; flagellar segments with abundant pale setæ. Head dark gray.

Mesonotum and pleura almost uniformly pale testaceous-brown to reddish brown. Halteres pale, the knobs weakly darkened. Legs with the coxæ and trochanters testaceous-yellow; femora whitish, the tips narrowly darkened; tibiæ and basitarsi dirty white, the tips narrowly darkened; outer tarsal segments darkened. Wings (Plate 1, fig. 7) whitish subhyaline, the oval stigma conspicuous, dark brown; veins yellow, beyond the cord more brownish yellow. Venation: Sc_1 ending shortly beyond midlength of Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 in approximate transverse alignment, or the latter a little more basad; cell 1st M_2 large, exceeding the veins beyond it; m-cu shortly beyond fork of M, subequal to the distal section of Cu_1.

Abdominal tergites brown, the sternites yellow. Male hypopygium (Plate 2, fig. 31) with the caudal border of the long tergite, 9*t*, convexly rounded. Basistyle, *b*, with the mesal armature consisting of three complex lobes; namely, first, a short flattened blade that terminates in a comblike series of acute spines; second, a dusky blade, the base narrow, the apex expanded, obliquely truncate, with long coarse setæ; third, a slender-based spatulate lobe, the dilated head with recurved delicate setæ. Dististyle, *d*, complicated by lobes and outgrowths, the most conspicuous element being a broadly flattened spatula that is densely clothed with long setæ. Gonapophyses, *g*, with the outer margin corrugated as in group.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg.*) Allotype, female, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Limonia (*Limonia*) *alopecura* resembles other species of the *pendleburyi* group in its general appearance but is very different in the unusually complicated male hypopygium, especially the basistyle.

LIMONIA (LIMONIA) INSCITA sp. nov. Plate 1, fig. 8; Plate 2, fig. 32.

General coloration of mesonotum brownish yellow to testaceous-yellow; knobs of halteres dark brown; wings with a faint brown tinge; stigma oval, a trifle darker than the ground; Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 at its tip; Rs angulated and weakly spurred at origin; male hypopygium with the dorsal dististyle microscopically setulose; ventral dististyle relatively small, the rostral prolongation with two spines, the innermost from an enlarged basal tubercle.

Male.—Length, about 4 millimeters; wing, 4.8.

Rostrum obscure yellow; palpi brownish black. Antennæ with the basal segments damaged; flagellum black; flagellar segments oval. Head dark gray.

Pronotum yellowish testaceous, with long erect black setæ. Mesonotum gibbous, brownish yellow to brownish testaceous. Pleura testaceous-yellow. Halteres with the stem pale, the base yellow, the knob dark brown. Legs with the coxæ and trochanters yellow; femora testaceous-brown, the outer segments of the tarsi slightly darker. Wings (Plate 1, fig. 8) with a very faint brown tinge; stigma oval, a trifle darker brown; veins brown. Venation: Sc of moderate length, Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 at its tip; Rs angulated and weakly spurred at origin; free tip of Sc_2 and R_2 in alignment; m-cu oblique, just before the fork of M, subequal to the distal section of Cu_1; anal veins parallel at origin.

Abdomen dark brown; hypopygium pale. Male hypopygium (Plate 2, fig. 32) with the caudal margin of the tergite, 9*t*, strongly notched medially. Basistyle, *b*, relatively small, the mesal lobe large. Dorsal dististyle, *dd*, with the surface on basal two-thirds with microscopic setulæ. Ventral dististyle, *vd*, subequal in area to the basistyle; prolongation with two strong spines of equal length, placed close together on basal third of prolongation; inner spine from a more strongly de-

veloped tubercle than the outer spine. Gonapophyses, *g*, with the mesal-apical lobe curved, blackened.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude about 1,500 feet, May 1, 1932 (*Gressitt*).

Limonia (*Limonia*) *inscita* is very different from other known species of the subgenus, as now known from the Japanese Empire. The type of hypopygium is somewhat as in *L.* (*L.*) *fusca* (Meigen), which is otherwise very different in the apically pubescent wings.

LIMONIA (EUGLOCHINA) CURTATA sp. nov. Plate 1, fig. 9.

General coloration of mesonotum shiny brown, the pleura more yellow; wings whitish subhyaline, the cells beyond cord weakly darkened; stigma oval, dark brown; Sc very short, the distance between arculus and tip of Sc_1 being shorter than the distance on R between Sc_2 and origin of Rs; Rs short, oblique; R_1 beyond Rs without further union with R_{2+3}; cell M_2 open by the atrophy of the basal section of M_3; m-cu nearly its own length beyond fork of M; vein 2d A ending distinctly beyond level of vein Sc.

Female.—Length, about 5.5 millimeters; wing, 5.8.

Rostrum and palpi brownish black. Antennæ with scape and pedicel brownish black; flagellum dark brown; antennæ relatively elongate; flagellar segments fusiform. Head brown.

Mesonotum almost uniform shiny brown, the pleura more yellowish. Halteres elongate, the stem brown, the knob brownish black. Legs with the coxæ yellow; trochanters testaceous; remainder of legs broken. Wings (Plate 1, fig. 9) whitish subhyaline, the cells beyond cord, together with the apical border, a trifle darker; stigma oval, dark brown; veins dark brown. Macrotrichia of veins long and conspicuous. Venation: Sc very short, the vein between arculus and its tip shorter than the distance on R between Sc_2 and origin of Rs; Rs very short, oblique, subequal in length to r-m, and with vein R_1 beyond it simple, without connection with R_{2+3}; basal section of R_{4+5} long and strongly arcuated; cell M_2 open by atrophy of basal section of vein M_3; m-cu nearly its own length beyond fork of M; vein 2d A ending distinctly beyond the level of end of vein Sc.

Abdomen with the segments brown, the basal portion a little brightened.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, female, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Limonia (*Euglochina*) *curtata* is very different from the other described species of *Euglochina* in the whitish subhyaline wings, the very short Sc, short Rs, entire atrophy of vein R_2, and the open cell M_2. All other described species of the subgenus have Sc longer, always exceeding the distance between Sc_2 and origin of Rs; Rs much longer than r-m; R_2 present, connecting R_{1+2} with R_3; and with cell 1st M_2 closed.

HELIUS (HELIUS) COPIOSUS sp. nov. Plate 1, fig. 10; Plate 2, fig. 33.

General coloration of mesonotum dark brown; antennæ relatively long, dark brown throughout; flagellar segments cylindrical, with abundant, dense, erect setæ that are almost as long as the short verticils; wings pale yellowish subhyaline; stigma long-oval, pale brown; Sc_1 ending opposite fork of Rs; cell 1st M_2 short-hexagonal, with m-cu at midlength.

Male.—Length, including rostrum, about 6.5 millimeters; wing, 7.

Rostrum relatively long and slender, a little longer than the remainder of head, dark brown; palpi black. Antennæ relatively elongate, dark brown throughout; flagellar segments cylindrical, with abundant dense erect setæ that are almost as long as the short verticils. Head blackish, sparsely pruinose.

Mesonotum chiefly dark brown, the scutellum more testaceous. Pleura more reddish brown. Halteres yellow, the knobs weakly darkened. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellow; femora and tibiæ pale brown, the tarsi passing into light yellow. Wings (Plate 1, fig. 10) pale yellowish subhyaline, the prearcular and costal regions a little brighter; stigma long-oval, pale brown; veins pale brown, more yellowish in the costal region. Anterior branch of Rs with relatively few macrotrichia, including about six or seven, widely scattered; other outer radial and medial veins with close, dense series of trichia; costal fringe of moderate length and very dense. Venation: Sc_1 terminating opposite fork of Rs; cell R_2 at margin narrow, subequal to m-cu; cell 1st M_2 short-hexagonal; veins issuing from cell 1st M_2 elongate; m-cu at midlength of the cell.

Abdomen dark brown; hypopygium yellow. Male hypopygium (Plate 2, fig. 33) with the basistyle, *b*, produced into a lobe on base of mesal face. Outer dististyle, *od*, short, blackened,

gently arcuated, the tip very weakly bidentate. What are presumably interbases, *i*, have the peculiar conformation shown in the figure. Ædeagus, *a*, weakly spiraliform at tip.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

By Edwards's synopsis of the Oriental species of *Helius* [4] the present fly runs to *Helius* (*Helius*) *kambangani* (de Meijere) and *H.* (*H.*) *fasciventris* Edwards, but differs from both in the body coloration and venation. In the two latter species, Sc is unusually long, extending almost to opposite the outer end of cell 1st M_2, which latter is of peculiar shape, with m oblique in position and longer than the basal section of M_3.

ORIMARGA (ORIMARGA) GYMNONEURA sp. nov. Plate 1, fig. 11; Plate 2, fig. 34.

General coloration dark gray; legs and antennæ black; wings grayish, very broad; wing veins unusually glabrous, there being no trichia on Rs or any of its branches; R_{2+3} about twice as long as R_2, the latter longer than R_{1+2}; male hypopygium with the outer dististyle broader and less acutely pointed than usual in the genus; inner dististyle near apex bent almost at a right angle into a slender lobe; gonapophyses and interbases appearing as slender acute spines.

Male.—Length, about 5 millimeters; wing, 5 by 1.6.

Rostrum brown; palpi black. Antennæ black throughout; flagellar segments oval. Head gray.

Mesonotum almost uniformly dark gray, the posterior sclerites more dusted with lighter gray. Pleura dark gray; dorsopleural region dark. Halteres pale, the knobs slightly dusky. Legs with the coxæ reddish, sparsely pruinose; trochanters brownish testaceous; remainder of legs brownish black. Wings (Plate 1, fig. 11) grayish, the prearcular and costal regions a trifle brighter; veins dark brown. Wings very broad, as shown by the measurements; macrotrichia of veins unusually sparse, there being none on any of the veins beyond level of fork of Rs, excepting two or three near outer ends of each of veins M_{1+2} and M_3; none on Rs or its branches. Venation: Sc_1 ending shortly before fork of Rs, Sc_2 at its tip; R_{2+3} about twice R_2, the latter longer than R_{1+2}; r-m lying slightly beyond level of R_2; m-cu opposite midlength of Rs; cell 2d A long-extended, its outer end opposite or shortly beyond m-cu.

[4] Journ. Fed. Malay St. Mus. 14 (1928) 85–86.

Abdomen dark reddish brown, the sternites a little brighter; hypopygium a little brighter. Male hypopygium (Plate 2, fig. 34) with the outer dististyle, *od*, much broader and less acutely pointed than is usual in the genus; inner dististyle, *id*, near apex bent almost at a right angle into a slender lobe. Gonapophyses, *g*, and interbases, *i*, appearing as slender acute spines, the tips narrowly pale.

Habitat.—Formosa (south).

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

The unusually glabrous veins and the very broad wings will readily separate the present fly from all other species of *Orimarga* in eastern Asia.

ORIMARGA (ORIMARGA) GRISEIPENNIS sp. nov. Plate 1, fig. 12.

General coloration of notum dark brown, grayish pruinose; rostrum obscure yellow; antennæ black throughout; legs black; wings grayish; macrotrichia on veins beyond cord relatively numerous; R_{2+3} fully one-half longer than R_2; petiole of cell M_3 relatively long, exceeding vein M_4; basal portion of vein M_3 distinctly preserved; m-cu nearly opposite midlength of Rs; abdomen reddish brown.

Female.—Length, about 5 millimeters; wing, 4.4.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments oval; verticils inconspicuous. Head dark gray.

Mesonotal præscutum and scutum dark brown, sparsely pruinose; scutellum reddish, very sparsely pruinose; mediotergite light gray. Pleura almost uniformly reddish yellow. Halteres pale, the base of stem yellow, the knobs weakly dusky. Legs with the coxæ reddish; trochanters more testaceous; remainder of legs black, the femoral bases restrictedly or scarcely brightened. Wings (Plate 1, fig. 12) grayish, the prearcular and costal regions more yellowish white; veins brown, slightly seamed with brown to produce a slight streaked appearance. Macrotrichia of veins beyond cord relatively abundant, there being close series on all of R_3 except the basal fourth; all of outer section of R_{4+5}, and on basal section of the latter except for the slightly deflected basal portion; on outer section of M_{1+2} except the basal fifth; on entire lengths of veins M_3 and M_4. Venation: Sc_1 ending beyond midlength of Rs, Sc_2 at its tip; no trace of the free tip of Sc_2; R_{2+3} about one-half longer than R_2, the latter a little shorter than R_{1+2}; petiole of cell M_3 long,

borneensis Brunetti, with which it agrees in the general appearance and venation, as the very short R_{1+2}. The latter species is well-distinguished from *toala* by details of venation, as the elongate Rs and the arcuated basal section of M_{1+2}, which is much longer than r-m and not in alignment with it; and by the more abundant and conspicuous macrotrichia of the radial veins, including a series of about fifteen distributed over almost the whole length of vein R_3.

ORIMARGA (ORIMARGA) HYPOPYGIALIS sp. nov. Plate 1, fig. 14; Plate 2, fig. 35.

General coloration brownish gray, the præscutum more blackened medially; wings with a faint brown tinge; macrotrichia of outer radial and medial veins dense and abundant; Rs short and angulated at origin; R_{1+2} long, approximately three times R_2 and nearly as long as R_{2+3}; cell M_3 deep; male hypopygium with the tergite conspicuous, deeply emarginate, the lobes broadly rounded and without specially modified setæ; lobe of basistyle tapering to a narrow point, with numerous fasciculate setæ.

Male.—Length, about 5 millimeters; wing, 6.

Rostrum and palpi black. Antennæ black throughout. Head dark gray, the anterior vertex somewhat brighter.

Mesonotal præscutum brownish gray, the median stripe blackish, somewhat polished; lateral stripes poorly indicated; posterior sclerites of notum gray. Pleura blackish, sparsely pruinose. Halteres pale. Legs with the coxæ brownish black, the fore coxæ somewhat darker; trochanters brownish black; remainder of legs dark brown or brownish black. Wings (Plate 1, fig. 14) with a faint brown tinge; veins brown. Macrotrichia of veins relatively abundant, including a series of about twelve on R_{1+2} and more than fifty on R_3 alone; complete dense series of trichia on all outer branches of R and M. Venation: Rs short and angulated near origin; R_{1+2} long, approximately three times R_2 and nearly as long as R_{2+3}; cell M_3 deep, M_{3+4} being about two-thirds M_4; m-cu just beyond the level of the bend of Rs.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 2, fig. 35) of the general type of *quadrilobata*, differing especially in the broad lobes of the tergite, 9*t*, which are evenly rounded and without a group of specially modified setæ on their internal margin, and in the narrow lobe of the basistyle, *b*. Both species have the dististyles of approximately

the same conformation and with the abundant setæ of the lobe of the basistyle strongly fasciculate.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

The closest ally of the present fly is undoubtedly *Orimarga* (*Orimarga*) *quadrilobata* Alexander (Mindanao), which differs in the venation, especially the short R_{1+2}, and in the details of the structure of the male hypopygium, as the conformation of the tergite and lobe of the basistyle. *Orimarga* (*O.*) *fryeri* Edwards (Seychelles Islands) and *O.* (*O.*) *flaviventris* Edwards (Key Islands) likewise have hair brushes on the basistyle of the hypopygium but are otherwise very different flies.

HEXATOMINI

EPIPHRAGMA (POLYPHRAGMA) MINAHASSANA sp. nov. Plate 1, fig. 15; Plate 3, fig. 36.

Belongs to the *ochrinota* group; mesonotum reddish brown, the surface very sparsely pruinose; pleura brownish black; darkened femoral ring pale brown; wings with a brown pattern that is narrowly bordered by yellow; male hypopygium with the interbase a simple rod, on outer fifth angularly bent to an acute point.

Male.—Length, about 7.5 millimeters; wing, 8.3.

Female.—Length, about 6.5 to 7 millimeters; wing, 6 to 6.5.

Rostrum and palpi brownish black. Antennæ with the scape brown, sparsely pruinose; pedicel and first two flagellar segments light orange-yellow; outer flagellar segments brown. Front and anterior vertex ashy gray; posterior vertex dark brown on central area, the lateral and orbital portions more fulvous.

Mesonotal præscutum and scutum reddish brown, the surface very sparsely pruinose; scutellum and mediotergite dark brown, sparsely pruinose. Pleura brownish black, immaculate, contrasting abruptly with the pale notum. Halteres with the stem yellow, narrowly darkened at extreme base, the knob infuscated. Legs with the fore and middle coxæ brownish yellow; posterior coxæ blackened; trochanters yellow; femora yellow, darkened to a pale brown subterminal ring, the tip again light yellow; tibiæ and tarsi yellow. Wings (Plate 1, fig. 15) with the ground color pale brown, variegated by darker brown spots and broken crossbands that are narrowly bordered by pale yellow; prearcular and costal regions yellow; cell C with about ten dark areas, some of which inclose spurs of crossveins; longitudinal veins at margin with brown spots, the ends of the correspond-

ing cells with yellow areas, more intense in the radial field; veins brown, more luteous in the costal field. Venation: R_{2+3+4} shorter than m-cu, the latter about one-half its length beyond the fork of M.

Abdomen dark brown, in male with intermediate portions of the sternites a little more yellowish. Male hypopygium (Plate 3, fig. 36) with the lobes of the tergite, *9t*, slender, separated by a U-shaped notch. Dististyles, *id*, *od*, relatively small. Interbase, *i*, a long, powerful, simple rod, on outer fifth bent at an angle to the acute point.

Habitat.—North Celebes (Minahassa).

Holotype, male, Roerockan, altitude 4,000 feet, April 18, 1931 (*Clagg*). Allotopotype, female. Paratopotype, female.

In my key to the species of *Polyphragma* [5] the present fly runs to *Epiphragma* (*Polyphragma*) *ochrinota* Alexander (Luzon), which is its nearest ally. The fly is most readily told by the hypopygial structures, especially of the tergite and interbase. The subgenus had previously been recorded only from Luzon, Mindanao, and Borneo.

LIMNOPHILA (TRICHOLIMNOPHILA) FEROCIA sp. nov. Plate 1, fig. 16; Plate 3, fig. 37.

General coloration of mesonotum opaque grayish brown, the præscutum without evident stripes; antennæ (male) elongate; femora obscure yellow; wings strongly tinged with brown, the base unbrightened; restricted darker brown seams at origin of Rs and along cord and outer end of cell 1st M_2; abdominal tergites dark brown, sternites brownish yellow; male hypopygium with the median lobe of tergite long and narrow, parallel-sided, the apex truncated; outer dististyle without spinous points on surface; phallosome with the gonapophyses simple, each appearing as a flattened, twisted blade that exceeds the ædeagus in length.

Male.—Length, about 5 millimeters; wing, 5.5 to 5.6; antenna, about 2.7.

Rostrum brownish black; palpi black. Antennæ (male) relatively elongate, as shown by the measurements, the individual segments a little longer than in *platystyla;* scape and pedicel brownish yellow; flagellum black, the extreme base of the first segment restrictedly pale; flagellar segments with verticils that are subequal in length to the segments. Head grayish brown.

[5] Philip. Journ. Sci. 49 (1932) 259–261.

Mesonotum opaque grayish brown, without evident stripes. Pleura dark grayish brown. Halteres with stem yellow, the knob dusky. Legs with fore coxæ brown, the remaining coxæ and all trochanters light yellow; femora obscure yellow; tibiæ brownish yellow, the tips narrowly dark brown; tarsi brownish black. Wings (Plate 1, fig. 16) strongly tinged with brown, the color uniform throughout except for darker brown areas at origin of Rs, Sc_2, stigma, cord, and outer end of cell 1st M_2; veins brown, somewhat darker in the infuscated areas. Macrotrichia in outer ends of cells R_2 to M_4, inclusive, more numerous in outer ends of the cells. Venation: Sc_1 longer than m-cu; R_2 pale but distinct, about one-half R_{1+2}; petiole of cell M_1 approximately one-half the cell; m-cu about one-third its length beyond the fork of M.

Abdominal tergites dark brown; sternite brownish yellow. Male hypopygium (Plate 3, fig. 37) with the median lobe of tergite, *9t*, long and narrow, the sides nearly parallel, the lateral portions more deflexed; from each outer lateral angle with a strong ridge directed cephalad. Apex of basistyle, *b*, narrowed into a glabrous subacute point. Outer dististyle, *od*, strongly flattened, as in *platystyla*, the surface much wrinkled but without spinous points, as in *platystyla* and its variety *parallela*. Inner dististyle, *id*, with the inner or cephalic lobe very small and weak. Phallosome with the gonapophyses, *g*, simple, each appearing as a flattened, twisted blade that is longer than the ædeagus, *a*.

Habitat.—Formosa (north).

Holotype, male, Sozan, altitude 1,000 feet, December 5, 1933 (*Issiki*). Paratopotypes, 2 males.

Limnophila (*Tricholimnophila*) *ferocia* is allied to *L.* (*T.*) *platystyla* Alexander and its race, *L.* (*T.*) *platystyla parallela* Alexander, likewise from Formosa, differing most evidently in the distinct structure of the male hypopygium, especially the glabrous outer dististyle, and the simple, very large and conspicuous gonapophyses. In the two forms listed, the latter structure is a profoundly bifid rod, the arms appearing as slender spines. The male sex of *L.* (*T.*) *excelsa* Alexander, from the high mountains of Formosa, is still unknown, but from the coloration it cannot be identical with the present fly.

ELEPHANTOMYIA (ELEPHANTOMYODES) INFUMOSA sp. nov. Plate 1, fig. 17.

General coloration of mesonotum dull brownish orange to reddish brown; head dark brown or brownish black; legs dark

brown, the tarsi extensively snowy white; wings strongly suffused with brown but otherwise unmarked except for the darker stigmal area; abdomen feebly bicolorous.

Male.—Length, excluding rostrum, about 6 to 7 millimeters; wing, 6.5 to 7.5; rostrum, about 4.5 to 5.5.

Female.—Length, excluding rostrum, about 6 millimeters; wing, 5.5; rostrum, about 3.5.

Rostrum dark brown, longer in male. Antennæ black throughout. Head dark brown to brownish black, the inner orbits very narrowly grayish.

Mesonotal præscutum dull brownish orange to reddish brown, in female narrowly darker brown on the median area; scutum and scutellum dull brownish orange, the mediotergite somewhat darker brown. Pleura dull brown. Halteres brownish black, the base of stem restrictedly paler, the knob more blackened. Legs with the coxæ brown; trochanters obscure yellow; femora and tibiæ dark brown; basitarsi chiefly dark brown, the narrow tips and all of segments two and three snowy white; outer tarsal segments darkened. Wings (Plate 1, fig. 17) uniformly suffused with brown but otherwise unmarked except for the darker stigmal area; veins brownish black. Venation: m-cu at from one-third to one-half the length of cell 1st M_2; vein 2d A relatively long, ending at midlength of wing.

Abdomen feebly bicolorous, the tergites dark brown, the basal rings of segments three to five narrowly yellow; sternites more diffusely patterned; outer abdominal segments and hypopygium brownish black.

Habitat.—Northern Celebes (Minahassa).

Holotype, male, Mount Rumengan, Roeroekan, altitude 4,000 feet, April 13, 1931 (*Clagg*); mating on leaf of *Pandanus*. Allotopotype, female, in copula with type. Paratopotypes, 2 males.

In its combination of brownish black head, white tarsi, and unpatterned wings, the present fly is most nearly allied to *Elephantomyia* (*Elephantomyodes*) *nigriceps* Edwards (Siam, Borneo), *E.* (*E.*) *nigriclava* Edwards (Borneo), and *E.* (*E.*) *samarensis* Alexander (Philippines), differing from all in the strongly suffused wings.

ERIOPTERINI

TRENTEPOHLIA (TRENTEPOHLIA) PROBA sp. nov. Plate 1, fig. 18.

General coloration brownish black; humeral region of præscutum a little more reddish brown; knobs of halteres brownish black; wings with the ground color whitish, cross-banded with

dark brown; pale band beyond cord almost parallel-sided, only slightly constricted at midlength; no pale spots in outer ends of cells R, M, and Cu; Rs shorter than R_{2+3+4}; R_2 subequal to R_{3+4}; m-cu just beyond fork of M.

Female.—Length, about 7 millimeters; wing, 7.

Rostrum black; palpi brown. Antennæ with the scape black, pedicel dark brown; flagellum broken. Head brownish black; vertex narrowed at a single point.

Pronotum and cervical sclerites black. Mesonotum dull brownish black, the humeral region of præscutum a little more reddish brown. Pleura brownish black, including the dorsopleural region. Halteres yellow, the knobs brownish black. Legs with the coxæ brownish black; trochanters obscure brownish yellow; remainder of legs broken. Wings (Plate 1, fig. 18) with the ground color whitish, cross-banded with dark brown; prearcular region and costal interspaces pale yellow; band of the ground color lying beyond cord almost parallel-sided and thus only slightly constricted along vein R_{4+5} and M_{1+2}; darkened apex variegated by a white spot in outer ends of cells R_3 and R_4; grayish washes in base of cell R_5 and outer end of cell M_2; outer ends of cells in medial dark band not variegated by pale spots, as in *pulchripennis;* veins brown, pale yellow in the clear areas. Venation: Sc_1 ending beyond fork of M; Rs shorter than R_{2+3+4}; R_2 subequal to R_{3+4}; veins R_3 and R_4 only slightly divergent, the former rather strongly upcurved at costa; m-cu just beyond fork of M.

Abdomen black; ovipositor and genital segment orange.

Habitat.—Formosa (north).

Holotype, female, Urai, altitude about 1,500 feet, May 1, 1932 (*Gressitt*).

Trentepohlia (*Trentepohlia*) *proba* is most nearly allied to *T.* (*T.*) *pulchripennis* Alexander (Formosa), which differs especially in the smaller size, light yellow to brownish yellow mesonotum, yellowish sternum and dorsopleural region, and the distinct venation, especially the long R_{3+4} which is subequal to the nearly erect R_3, and the distal position of the fork of M, with m-cu lying more than one-half its length before this fork.

GONOMYIA (LIPOPHLEPS) MITOPHORA sp. nov. Plate 1, fig. 19; Plate 3, fig. 38.

Belongs to the *skusei* group; mesonotal præscutum with three black or brownish black stripes that are confluent or nearly so; pleura reddish yellow to testaceous-yellow; legs dark brown; wings with a faint brown tinge; Sc relatively short for a mem-

ber of the group, Sc_1 ending shortly beyond origin of Rs; male hypopygium with the outer lobe of basistyle unusually long, cylindrical; dististyles of the two sides slightly asymmetrical.

Male.—Length, about 4.5 to 5 millimeters; wing, 4.5 to 5.

Female.—Length, about 5.5 to 6 millimeters; wing, 5 to 5.3.

Rostrum and palpi black. Antennæ black throughout; flagellar segments (male) with elongate verticils, as in the group. Head dark.

Pronotum darkened medially, yellow on sides. Mesonotal præscutum chiefly covered by black or brownish black stripes that are nearly or quite confluent, reducing or obliterating the usual interspaces; scutal lobes almost covered by black areas, the broad median region and the scutellum pale yellow; mediotergite reddish yellow. Pleura uniformly reddish yellow to testaceous-yellow, without distinct stripes. Halteres pale yellow, the base of knob a trifle darkened. Legs with the coxæ obscure yellow, the fore coxæ a trifle darker; trochanters yellow; remainder of legs uniformly dark brown. Wings (Plate 1, fig. 19) with a faint brown tinge, the stigmal area scarcely darkened; veins pale brown. Venation: Sc_1 ending a trifle beyond the origin of Rs, Sc_2 opposite or close to this origin; basal section of R_5 of variable length, in cases very much reduced; branches of Rs elongate, more or less parallel on basal third; cell 1st M_2 closed; m-cu at or beyond the fork of M.

Abdominal tergites brownish yellow, the sternites more yellowish, with a more or less definite median darkening; hypopygium relatively large and conspicuous. Male hypopygium (Plate 3, fig. 38) with the outer lobe of basistyle, *b*, unusually long and slender, cylindrical, pale, with long erect setæ on mesal face. Distityles, *d*, of the two sides slightly asymmetrical, in one the apical spine long and slender, gently sinuous, on the opposite side the corresponding spine shorter, more flattened, sinuous. Phallosome, *p*, a flattened compressed blade, bearing a large spinous point on basal third where the structure is strongly narrowed, thence dilated into a spatula.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 12 of both sexes, May 15–16, 1931.

Gonomyia (*Lipophleps*) *mitophora* is readily told from all allied species of the subgenus by the coloration, venation, and structure of the male hypopygium. I am referring it to the

skusei group, despite the relatively short Sc which, in some cases, extends only to a slight distance beyond the origin of Rs.

GONOMYIA (LIPOPHLEPS) PERVILIS sp. nov. Plate 1, fig. 20; Plate 3, fig. 39.

Allied to *diacantha;* male hypopygium with the outer dististyle stout on basal half, the outer portion produced into a long smooth rod, at base on mesal edge with two blackened spines; cephalic-mesal portion of style further produced into a slender darkened rod; inner dististyle terminating in a relatively short spine; phallosome consisting chiefly of two flattened pale blades.

Male.—Length, about 3 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ chiefly black, the pedicel a little brightened. Head chiefly dark gray.

Pronotum and anterior lateral pretergites pale yellow. Mesonotum chiefly gray, the humeral region of præscutum restrictedly brightened; scutellum vaguely brightened on basal portion. Pleura dark, with a conspicuous silvery white longitudinal stripe extending from behind the fore coxæ to the meral region. Halteres dusky, the knobs obscure yellow. Legs with the fore coxæ brownish yellow; remaining coxæ darker; trochanters brownish testaceous; femora pale brown, the bases a little brightened, the tips narrowly darker brown; tibiæ and tarsi dark brown; femora with a row of evenly spaced erect setæ on ventral face, longer and more conspicuous on posterior femora. Wings (Plate 1, fig. 20) whitish subhyaline, clouded with darker, including major areas in all basal cells, especially R, along cord and in outer radial field; stigma long-oval, dark brown; veins brown, more yellowish in the ground areas. Venation: Sc_1 ending a short distance before the origin of Rs, the degree a little shorter than m-cu; anterior branch of Rs paralleling R_1; r-m long, arcuated; m-cu before the fork of M.

Abdomen dark brown; hypopygium yellow. Male hypopygium (Plate 3, fig. 39) with the outer dististyle, *od*, stout on basal portion, the outer part produced into a long, gently arcuated rod, its tip obtuse, the margin smooth; at base of this rod, on inner aspect with two blackened spines, the mesal one a little longer; on mesal face of style near base a further slender dark arm that bears a small subapical spine. Inner dististyle, *id*, with the apical spine short. Phallosome, *p*, appearing chiefly as two flattened pale blades that fill the whole genital chamber.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 17, 1931 (*Clagg*).

Gonomyia (*Lipophleps*) *pervilis* is most nearly allied to *G.* (*L.*) *diacantha* Alexander (Mindanao), differing conspicuously in the structure of the phallosome and outer dististyle.

GONOMYIA (LIPOPHLEPS) GRESSITTI sp. nov. Plate 3, fig. 40.

Belongs to the *diffusa* group; male hypopygium with three dististyles, the intermediate one a long simple pale spine; inner style widely separated from the outer, appearing as a flattened blade that is narrowed on outer third into a slenderer blade whose base is surrounded by several setæ.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum and palpi dark. Antennæ with scape dark; remainder of antennæ broken. Head chiefly dark.

Anterior lateral pretergites light yellow. Mesonotal præscutum and scutum brownish gray; humeral region of the former restrictedly paler; scutal lobes with posterior callosities light yellow; scutellum with posterior border broadly pale yellow. Pleura chiefly dark brown with a conspicuous silvery white longitudinal stripe, extending from above the fore coxæ to the base of abdomen. Legs with the femora obscure yellow, with a broad black terminal (forelegs) to nearly terminal ring; tibiæ obscure yellow, the bases and tips narrowly blackened; basitarsi obscure brownish yellow, the tips and remainder of tarsi black. Wings with a faint grayish tinge; stigma barely evident; veins pale brown. Venation: Sc relatively long, Sc_1 ending shortly before origin of Rs, Sc_2 close to its tip; anterior branch of Rs nearly straight and extending nearly parallel to R_1; m-cu shortly before the fork of M.

Abdominal tergites black, the caudal borders of the segments narrowly yellow. Male hypopygium (Plate 3, fig. 40) of the general type of *jacobsoniana* or *ramifera*, differing in all details. Outer dististyle, *od*, a gently arcuated simple rod; intermediate style, *md*, nearly as long, appearing as a slender pale needlelike spine; inner style, *id*, placed low down on the mesal face of basistyle, as in the group, appearing as a flattened blade, on about the outer third suddenly narrowed into a slenderer blade, at base of the latter with a group of several coarse setæ; base of inner style on cephalic portion with a group of setæ.

Habitat.—Formosa (south).

Holotype, male, Rokki, near river, altitude 400 to 500 feet, June 14, 1932 (*Gressitt*).

I take great pleasure in naming this distinct species in honor of the collector, Mr. J. Linsley Gressitt, to whom I am indebted

for several interesting Tipulidæ from Honshiu and Formosa. The nearest allies are *Gonomyia* (*Lipophleps*) *jacobsoniana* Alexander and *G.* (*L.*) *ramifera* Alexander (Sumatra to Mindanao), which differ most evidently in the structure of the male hypopygia.

ORMOSIA DIVERSIPENNIS sp. nov. Plate 1, fig. 21.

Mesonotal præscutum and scutum light brown, the posterior sclerites of mesonotum and the pleura darker brown; knobs of halteres light yellow; legs yellow, the femora with a narrow brown subterminal ring and indications of a broader but more diffuse annulus before midlength; wings buffy yellow, variegated over the entire surface by abundant patches of dark-colored trichia; outer ends of marginal cells yellow; abdomen dark brown.

Female.—Length, about 4 millimeters; wing, 4.8.

Rostrum brown; palpi brownish black. Antennæ brown, the flagellar segments vaguely bicolorous by having their apices slightly pale. Head dark brown, with conspicuous yellow setæ.

Mesonotal præscutum light brown, without markings; pseudosutural foveæ black, the tuberculate pits small and paler; setæ of interspaces yellow, long, and conspicuous; scutum light brown; scutellum and mediotergite darker brown, with indications of a dark median dash on scutum and scutellum. Pleura darker brown than the præscutum. Halteres pale, the knobs large, light yellow. Legs with the coxæ brown; trochanters brownish yellow; femora yellow, with a narrow brown subterminal ring; most of the femora are also more or less darkened on basal half, leaving a broad ring of the ground color at and beyond midlength; tibiæ and tarsi light yellow, the outer tarsal segments darker. Wings (Plate 1, fig. 21) with the ground color buffy yellow, the costal and apical borders extensively brighter yellow; entire surface of wing variegated by large patches of dark-colored trichia, these occurring in almost all cells; trichia elsewhere on disk light yellow, the total area of light and dark patches being not greatly disproportionate; conspicuous yellow areas at ends of all marginal cells; veins yellow, darker in the clouded areas. Macrotrichia of cells long and conspicuous. Venation: Tips of veins R_3 and R_4 strongly deflected cephalad; cell 1st M_2 open by atrophy of basal section of M_3.

Abdomen dark brown. Valves of ovipositor long and conspicuous, dark horn-color.

Habitat.—Formosa (south).

Holotype, female, Sekisan, altitude 6,000 feet, August 15, 1933 (*Issiki*).

Ormosia diversipennis is readily told from allied regional species of the genus by the pattern of the wings and legs, especially the former.

CRYPTOLABIS (BÆOURA) CONSOCIA sp. nov. Plate 1, fig. 22; Plate 3, fig. 41.

General coloration dark gray; antennæ black throughout; legs black, the setæ not conspicuously outspreading; scutellum behind broadly yellow; male hypopygium with the dististyle strongly narrowed on outer half into a fingerlike lobe; gonapophysis a flattened blade that bears two large triangular points.

Male.—Length, about 4.5 millimeters; wing, 4.8.

Rostrum dark above, yellow laterally; basal segments of palpi obscure yellow, the outer segments blackened. Antennæ black throughout, the scape a little pruinose; pedicel larger than the scape; basal flagellar segments short-oval to subcylindrical, the outer segments more elongate, with conspicuous verticils. Head light gray.

Pronotum brownish gray, narrowly yellow on sides. Anterior lateral pretergites yellow, variegated by dark brown spots. Mesonotal præscutum dark gray, with indications of a darker median stripe; scutum similarly darkened, the outer lateral portions more yellow; scutellum dark basally, the margin broadly yellow; mediotergite gray. Pleura gray; dorsopleural membrane paler. Halteres dusky. Legs with the coxæ dark; trochanters brownish testaceous; remainder of legs black, with chiefly yellow setæ of moderate length. Wings (Plate 1, fig. 22) with a grayish tinge, the prearcular and costal regions more nearly whitish; stigma faintly indicated; scarcely evident darkenings along cord; veins brown. Venation: Sc_1 ending just before R_2, Sc_2 some distance from its tip; R_3 lying close to R_{1+2}, a little constricting the cell before midlength; m-cu more than three-fourths its length beyond the fork of M; cell 2d A wide.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 3, fig. 41) with the tergite, 9*t*, conspicuous, the outer lateral angles appearing as glabrous, obtuse, earlike lobes. Dististyle, *d*, with the outer half strongly narrowed into a fingerlike lobe. Gonapophyses, *g*, appearing as pale yellow flattened blades, with two strong triangular points, the lateral point or spine larger than the apical one; outer margin of outer point and lower margin of lateral one with microscopic denticles.

Habitat.—Formosa (central).

Holotype, male, Heiganzan to Pianan-Anbu, Taichû-shû, July 19, 1932 (*Esaki*).

Cryptolabis (*Bæoura*) *consocia* is most nearly allied to *C.* (*B.*) *aliena* (Alexander), differing especially in the details of structure of the male hypopygium. The hypopygium of *aliena* is shown for comparison (Plate 3, fig. 42), the most conspicuous differences being the more evident ears of the tergite, 9*t*, the longer apical point of the dististyle, *d*, and, especially, the differently shaped gonapophyses, *g*, with the outer point or lobe obtuse and microscopically roughened, the lateral point a very long and slender, gently arcuated blade.

CRYPTOLABIS (BÆOURA) LÆVILOBATA sp. nov. Plate 1, fig. 23; Plate 3, fig. 43.

General coloration of thorax and abdomen dull black; head light gray; setæ of legs long and conspicuous, erect; wings almost uniformly tinged with blackish, the apical cells paler; male hypopygium with the tergite strongly narrowed outwardly, terminating in two slender glabrous lobes that are separated from one another only by a deep U-shaped notch, the margins of the lobes smooth; fused gonapophyses with a median lobule between the short fleshy arms.

Male.—Length, about 4 millimeters; wing, 4.6.

Female.—Length, about 4 millimeters; wing, 5.4.

Rostrum dark brown; palpi black. Antennæ black throughout. Head light gray.

Mesonotum almost entirely deep black, only moderately polished; scutellum obscure yellow. Pleura dull black. Halteres with the stem dark, the base narrowly pale, the knob yellow. Legs with the coxæ and trochanters brownish black; remainder of legs brownish black, conspicuously hairy. Wings (Plate 1, fig. 23) with an almost uniform blackish tinge, the apex narrowly paler; stigma appearing as a linear darkened seam on R_{1+2}; veins and macrotrichia black. Venation: Sc_1 ending shortly beyond the fork of Rs, Sc_2 some distance before this fork; R_{2+3} a trifle longer than R_2 alone; m-cu close to midlength of M_{3+4}.

Abdomen dull black, including the genitalia of both sexes. Male hypopygium (Plate 3, fig. 43) with the ninth tergite, 9*t*, strongly narrowed outwardly, terminating in two slender glabrous lobes that are separated from one another only by a deep and narrow U-shaped notch; margins of the lobes smooth and without setæ. Dististyle, *d*, shorter than in *trichopoda*. What

are interpreted as being gonapophyses, *g*, appear as two short divergent arms, with the median area produced to lie beyond the level of these arms.

Habitat.—Formosa (north).

Holotype, male, Rimozan, May 2, 1933 (*Issiki*). Allotopotype, female.

The nearest ally of the present fly is undoubtedly *Cryptolabis* (*Bæoura*) *trichopoda* Alexander (southern Formosa) which, while very similar in general appearance, yet is conspicuously different in the structure of the hypopygium. It should be noted that these two species have the internal structures of the hypopygium very different from the other Formosan species, the large and prominent gonapophyses of *aliena* Alexander and *consocia* sp. nov., here being lacking or greatly reduced in size, or else being represented by the fused median structure (Plate 3, fig. 43, *g*), which would then form a phallosomic structure similar to that found in the genus *Molophilus*.

CRYPTOLABIS (BÆOURA) TRICHOPODA HASSENENSIS subsp. nov. Plate 3, fig. 44.

Male.—Length, about 4 millimeters; wing, 4.6.

Characters as in typical *trichopoda* Alexander, differing especially in slight details of structure of the male hypopygium (Plate 3, fig. 44). Ninth tergite, 9*t*, with the lateral lobes very conspicuous, separated by a U-shaped notch, the flattened margins of the lobes with delicate serrations. Dististyle, *d*, more evenly curved.

Habitat.—Formosa (central).

Holotype, male, Hassenzan, Kahodai to Reimei, Taichû-shû, July 12, 1932, (*Esaki*).

MOLOPHILUS CELEBESICUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 45.

Belongs to the *gracilis* group and subgroup; general coloration black; antennæ (male) of moderate length, brownish black throughout; wings very strongly tinged with brownish black; male hypopygium with all lobes of basistyle obtuse at tips; outer dististyle a slender, nearly straight rod, the outer end microscopically roughened; inner dististyle of similar length but broader, at near two-thirds the length with the margin produced into an acute blackened spine.

Male.—Length, about 3.8 to 4 millimeters; wing, 4.6 to 4.8.

Rostrum and palpi black. Antennæ (male) moderately elongate, if bent backward extending to the wing root, brownish black throughout. Head black, with a sparse pruinosity.

Mesonotum black, the anterior lateral pretergites restrictedly more reddish brown. Pleura dull black. Halteres brownish black. Legs brownish black throughout. Wings (Plate 1, fig. 24) very strongly suffused with brownish black; veins a little darker than the ground color; macrotrichia unusually long and conspicuous. Venation: R_2 lying shortly beyond the level of r-m; vein 2d A extending to about opposite the basal fifth of the petiole of cell M_3.

Abdomen, including the hypopygium, black. Male hypopygium (Plate 3, fig. 45) with all lobes of basistyle, *b*, obtuse, unarmed with spinous points. Outer dististyle, *od*, a small, slender, nearly straight rod, its outer end microscopically roughened. Inner dististyle, *id*, of about the same length as the outer, appearing as a straight flattened rod, at near two-thirds the length with the margin produced into an acute black spine, surrounding the base of which are several delicate setæ, additional to the rather numerous setigerous punctures elsewhere on the sclerite.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg*). Paratopotypes, 3 males.

Molophilus celebesicus is very different from all other black species of the genus in the structure of the male hypopygium, more especially of the inner dististyle.

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *md*, intermediate dististyle; *od*, outer dististyle; *p*, phallosome; *t*, tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Tipula* (*Lunatipula*) *multibarbata* sp. nov., venation.
2. *Dolichopeza* (*Nesopeza*) *toala* sp. nov., venation.
3. *Dolichopeza* (*Nesopeza*) *profundemarginata* sp. nov., venation.
4. *Dolichopeza* (*Nesopeza*) *toraja* sp. nov., venation.
5. *Limonia* (*Libnotes*) *falsa* sp. nov., venation.
6. *Limonia* (*Libnotes*) *comissabunda* sp. nov., venation.
7. *Limonia* (*Limonia*) *alopecura* sp. nov., venation.
8. *Limonia* (*Limonia*) *inscita* sp. nov., venation.
9. *Limonia* (*Euglochina*) *curtata* sp. nov., venation.
10. *Helius* (*Helius*) *copiosus* sp. nov., venation.
11. *Orimarga* (*Orimarga*) *gymnoneura* sp. nov., venation.
12. *Orimarga* (*Orimarga*) *griseipennis* sp. nov., venation.
13. *Orimarga* (*Orimarga*) *toala* sp. nov., venation.
14. *Orimarga* (*Orimarga*) *hypopygialis* sp. nov., venation.
15. *Epiphragma* (*Polyphragma*) *minahassana* sp. nov., venation.
16. *Limnophila* (*Tricholimnophila*) *ferocia* sp. nov., venation.
17. *Elephantomyia* (*Elephantomyodes*) *infumosa* sp. nov., venation.
18. *Trentepohlia* (*Trentepohlia*) *proba* sp. nov., venation.
19. *Gonomyia* (*Lipophleps*) *mitophora* sp. nov., venation.
20. *Gonomyia* (*Lipophleps*) *pervilis* sp. nov., venation.
21. *Ormosia diversipennis* sp. nov., venation.
22. *Cryptolabis* (*Bæoura*) *consocia* sp. nov., venation.
23. *Cryptolabis* (*Bæoura*) *lævilobata* sp. nov., venation.
24. *Molophilus celebesicus* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Lunatipula*) *multibarbata* sp. nov., male hypopygium, details.
26. *Tipula* (*Lunatipula*) *multibarbata* sp. nov., male hypopygium, eighth sternite.
27. *Dolichopeza* (*Nesopeza*) *toala* sp. nov., male hypopygium, details.
28. *Dolichopeza* (*Nesopeza*) *profundemarginata* sp. nov., male hypopygium, details.
29. *Dolichopeza* (*Nesopeza*) *toraja* sp. nov., male hypopygium, details.
30. *Limonia* (*Libnotes*) *falsa* sp. nov., male hypopygium.
31. *Limonia* (*Limonia*) *alopecura* sp. nov., male hypopygium.
32. *Limonia* (*Limonia*) *inscita* sp. nov., male hypopygium.
33. *Helius* (*Helius*) *copiosus* sp. nov., male hypopygium.
34. *Orimarga* (*Orimarga*) *gymnoneura* sp. nov., male hypopygium.
35. *Orimarga* (*Orimarga*) *hypopygialis* sp. nov., male hypopygium.

PLATE 3

FIG. 36. *Epiphragma* (*Polyphragma*) *minahassana* sp. nov., male hypopygium.
37. *Limnophila* (*Tricholimnophila*) *ferocia* sp. nov., male hypopygium.
38. *Gonomyia* (*Lipophleps*) *mitophora* sp. nov., male hypopygium.
39. *Gonomyia* (*Lipophleps*) *pervilis* sp. nov., male hypopygium.
40. *Gonomyia* (*Lipophleps*) *gressitti* sp. nov., male hypopygium.
41. *Cryptolabis* (*Bæoura*) *consocia* sp. nov., male hypopygium.
42. *Cryptolabis* (*Bæoura*) *aliena* Alexander, male hypopygium.
43. *Cryptolabis* (*Bæoura*) *lævilobata* sp. nov., male hypopygium.
44. *Cryptolabis* (*Bæoura*) *trichopoda hassenensis* subsp. nov., male hypopygium.
45. *Molophilus celebesicus* sp. nov., male hypopygium.

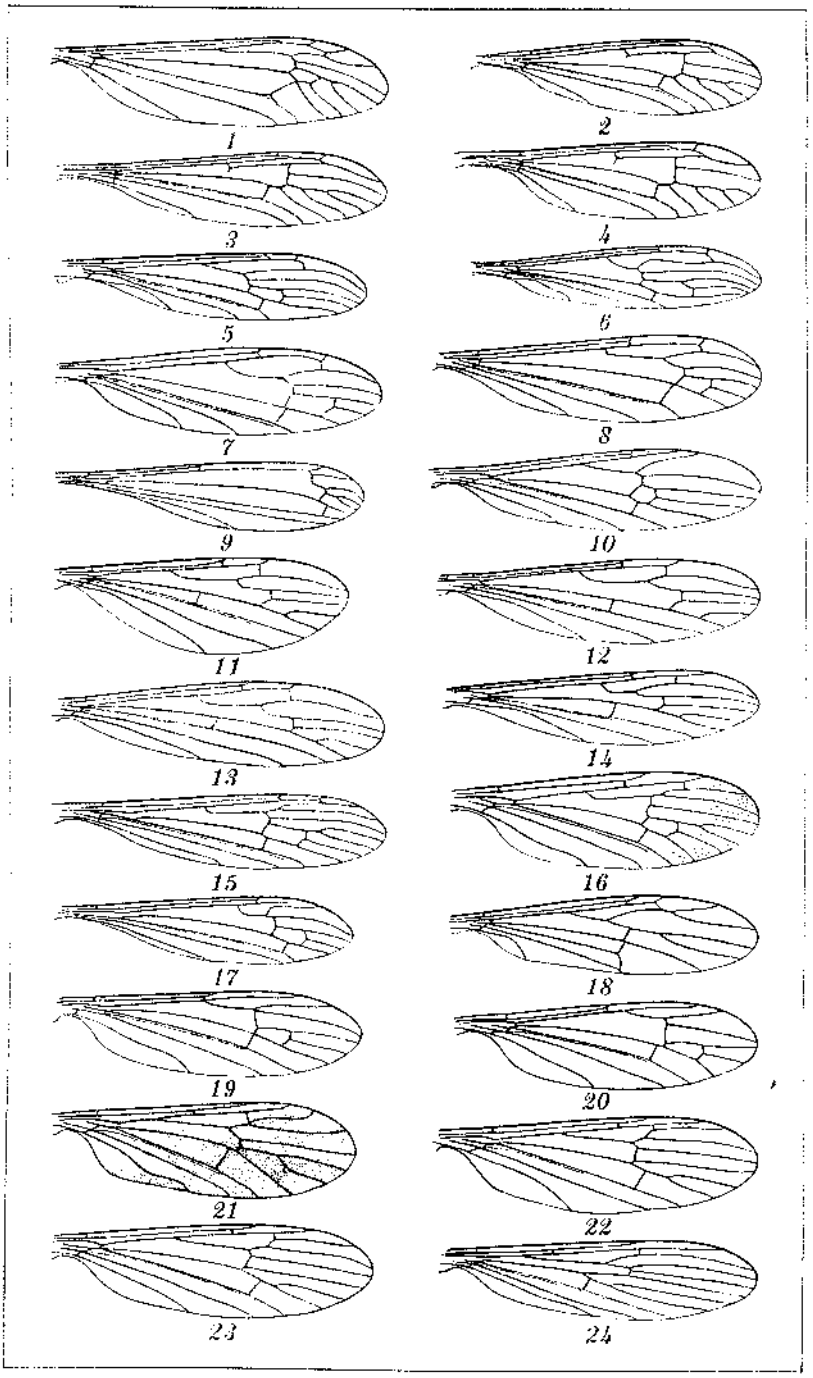

PLATE 1.

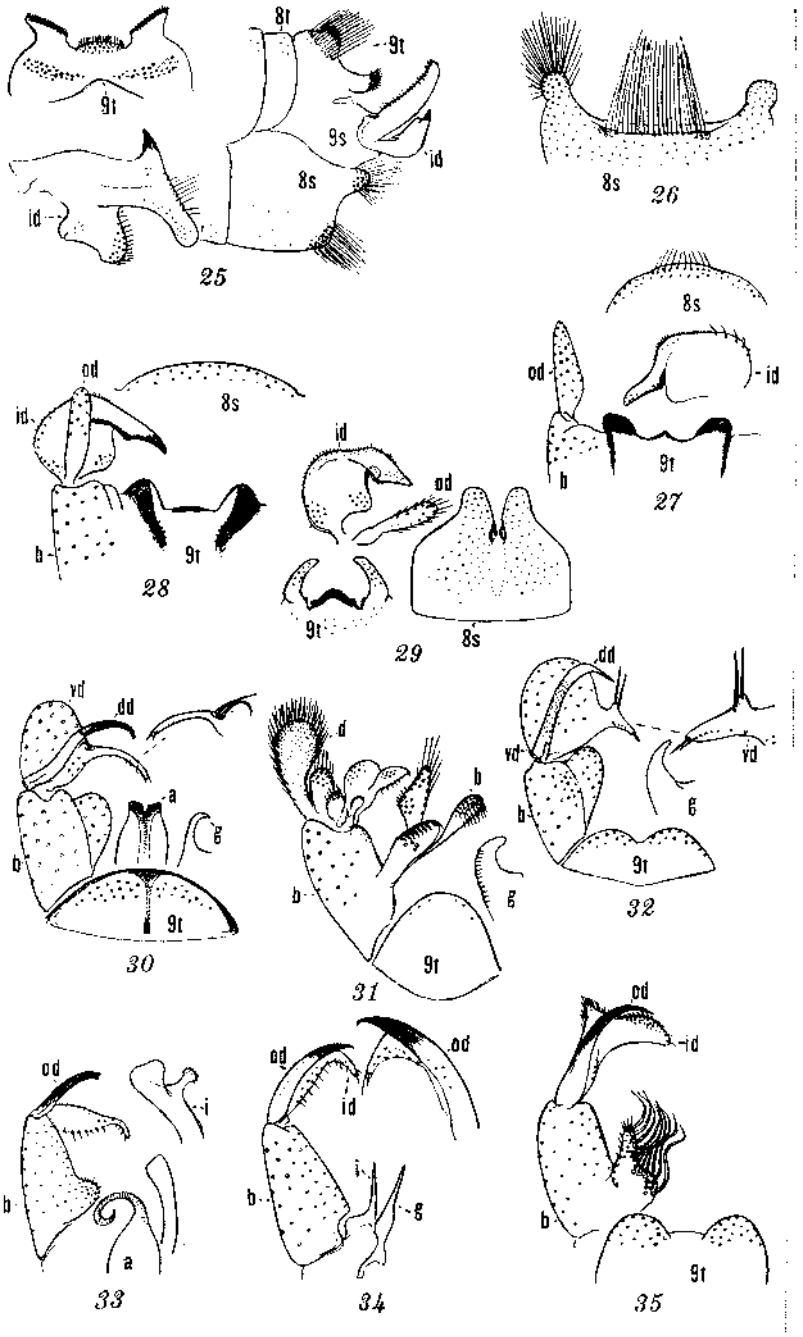
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PLATE 2.

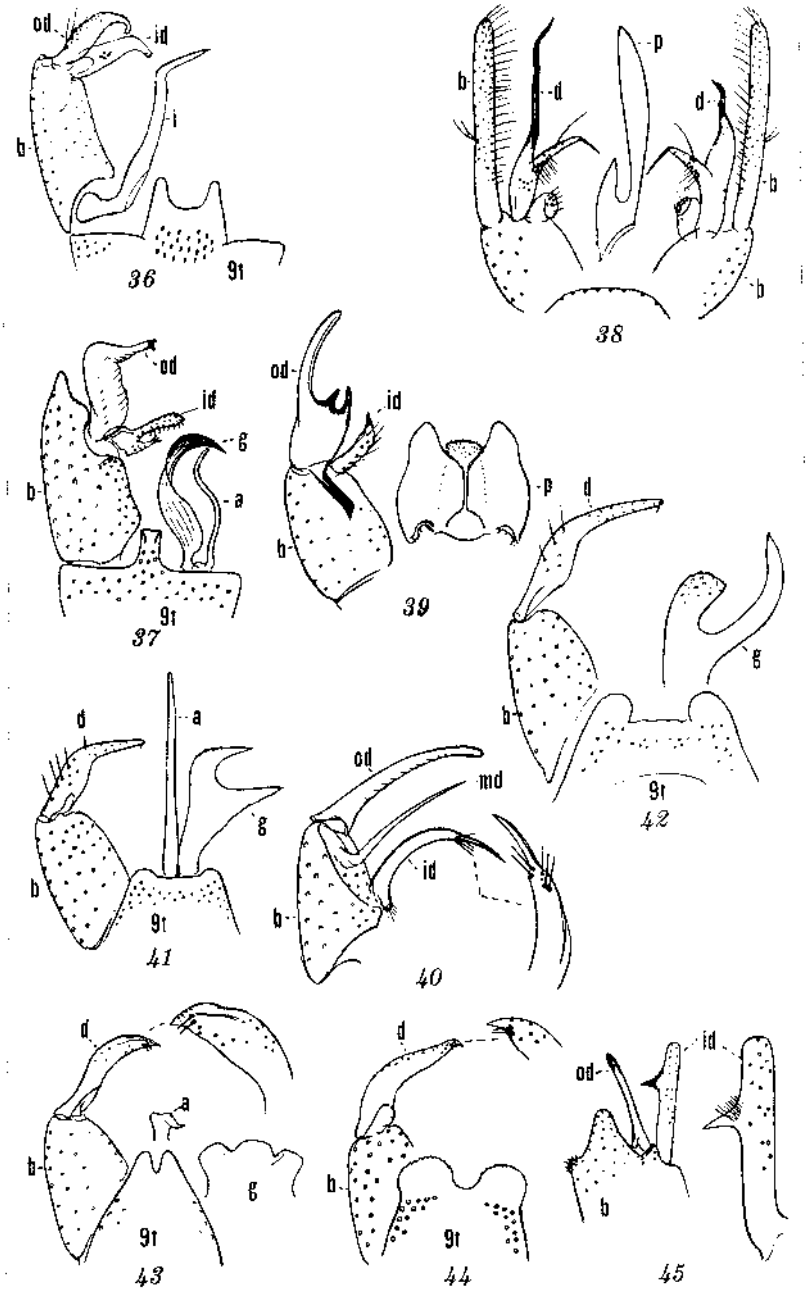
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PLATE 3.

THE PHYSIOLOGY OF REPRODUCTION IN SWINE, III

PRELIMINARY STUDY OF THE MORPHOLOGY OF THE SPERMATOZOA [1]

By AGUSTIN RODOLFO

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ONE PLATE

The presence of three different types of spermatozoa in the semen of the boar, the relative number of which is fairly constant, evokes considerable interest. They are distinguishable from one another by the absence or presence on the flagellum of a protoplasmic drop and by the position assumed by the drop on the tail. Measurements made of these types show that they also differ in size. On the significance of these different types, however, no information can be given here.

TYPES OF SPERMATOZOA

The spermatozoa of the boar are of three different types, which for present purposes may be designated I, II, and III, as on Plate 1.

The second type has the droplike protoplasmic structure attached on the proximal end of the middle piece, just below the neck, and the third has it at about the end of the upper third of the flagellum. This droplike structure appears to be a remnant of the cytoplasm of the differentiating spermatid. The first, which does not have the protoplasmic drop, is taken to be the normal type, largely because it ordinarily constitutes the greatest number in the semen.

The manner of attachment of the "drop" to the flagellum can best be studied by focusing the 4-mm objective up and down with the fine adjustment on a specimen that is still moving normally but relatively slowly. Such a specimen is suitable for study because no postmortem changes have set in, and because whether or not the "drop" surrounds the flagellum can be ade-

[1] This is the third paper of a series, the materials for which were worked out during the writer's stay in Soviet Russia.

quately observed. The difference in refractive index between the flagellum and the "drop" enables one to determine that the "drop" surrounds the flagellum completely. The flagellum is straight at the point where the "drop" is attached. In most specimens observed, the "drop" surrounded the tail symmetrically; in a few cases, however, symmetry is lacking.

The development of these types can be traced. If samples of spermatozoa are taken from the different parts of the epididymis, going from the proximal towards the distal portion, two facts become evident. First, the motility of the spermatozoa gradually increases as they move away from the proximal portion and approach the distal portion of the epididymis. In the proximal portion of the epididymis only nonmotile spermatozoa are encountered, while in the caudal portion only motile types are normally present. Second, most of the spermatozoa undergo a transformation from type II to type III, and finally to type I. From the proximal part of the epididymis only type II spermatozoa are present. As samples are taken towards the middle portion of the epididymis, type III soon makes its appearance, and gradually increases in number while type II correspondingly decreases. Finally type I appears, gradually becoming more numerous until it predominates over both types II and III. Not all spermatozoa, however, undergo the full process of transformation from type II to III and finally to I; some remain as type II and others as type III.

This phenomenon is not confined to the boar. Other workers, notably Hammar (1897) in the dog, Tournade and Regaud (1911) in the rat, Tournade (1913) in the rat, rabbit, guinea pig, and dog, and Young (1929) in the guinea pig, rat, ram, and bull, have observed that the spermatozoa removed from the proximal portion of the epididymis are nonmotile, or at most only slightly motile, while those removed from the posterior levels are motile.

Thus it appears that the spermatozoa undergo a sort of maturation in the epididymis and that type II is the most primitive form, III an intermediate form, and I the predominating type in the ordinary semen, the completely differentiated or matured type. From this standpoint both types II and III may be considered as immature types, type III being the more differentiated of the two.

On the other hand, if types II and III in the semen are immature—that is, not fully differentiated—two things are logically

to be expected; namely, (*a*) the proportion of types II and III to type I in the semen should increase in the course of intensive mating; and (*b*) there should be no distinct measurable differences among these types.

(*a*) *The relative proportions of the three types in intensively mated boars.*—The more intensively a boar is mated, the greater is the demand for the ejection of spermatozoa, and the shorter is the stay of the spermatozoa in the epididymis. During the early part of a period of intensive mating the normal expectation is for the ejection of type I and only a few of types II and III, if any. Now, in the first place the fact that the second mating in a day gives only a relatively meager number of spermatozoa, in spite of the presence in the epididymis of a greater number of spermatozoa than can be ejected in a number of ejections, was adduced in the first paper of this series as the basis for the suggestion that the spermatozoa need a certain minimum length of time in order to complete the process of transformation from the nonmotile type II to the motile types at the caudal portion of the epididymis. If this be so, one would expect that in the later part of a period of intensive mating—since there is less and less time for the transformation of the spermatozoa from types II and III to I—the proportion of immature gametes should increase with, at least in direct proportion to, the intensiveness of the mating and the progress of the period. Tables 1 to 3 show what takes place in the relative numbers of these various types as the boars are mated intensively.

TABLE 1.—*Relative numbers of the three types of spermatozoa of boars mated twice every other day.*

Boar No.	Time of day.	July 2.			July 3.			July 4.		
		I	II	III	I	II	III	I	II	III
2485/27	a. m.	436	5	59	[a]	[a]	[a]	465	------	35
	p. m.	467	5	28	[a]	[a]	[a]	500	------	------
2486/28	a. m.	422	1	77	[a]	[a]	[a]	486	1	13
	p. m.	428	4	68	[a]	[a]	[a]	492	------	8
2196/87	a. m.	------	[b]	------	------	[c]	------	------	[d]	------
	p. m.	------	[b]	------	270	145	85	------	[d]	------
1887/284	a. m.	------	[b]	------	355	43	102	------	[d]	------
	p. m.	------	[b]	------	------	[b]	------	------	[d]	------
2200/91	a. m.	------	[a]	------	130	302	68	------	[d]	------
	p. m.	------	[a]	------	------	[c]	------	------	[d]	------

[a] Not mated. [b] Did not mate. [c] No spermatozoa in secretion. [d] Rest.

TABLE 1.—*Relative numbers of the three types of spermatozoa of boars mated twice every other day*—Continued.

Boar No.	Time of day.	July 5.			July 6.			July 7.			July 8.		
		I	II	III	I	II	III	I	II	III	I	II	III
2485/27	a. m.	[d]	[d]	[d]	496	-----	4	[d]	[d]	[d]	500	-----	-----
	p. m.	[d]	[d]	[d]	500	-----	-----	[d]	[d]	[d]	499	-----	1
2486/28	a. m.	[d]	[d]	[d]	498	-----	2	[d]	[d]	[d]	494	3	3
	p. m.	[d]	[d]	[d]	475	6	19	[d]	[d]	[d]	496	1	3
2196/87	a. m.	461	16	23	-----	[d]	-----	471	16	13	-----	[a]	-----
	p. m.	500	-----	-----	-----	[d]	-----	-----	[b]	-----	-----	[a]	-----
1887/284	a. m.	418	7	75	-----	[d]	-----	-----	[b]	-----	-----	[a]	-----
	p. m.	491	-----	9	-----	[d]	-----	-----	[b]	-----	-----	[a]	-----
2200/91	a. m.	165	261	74	-----	[d]	-----	-----	[b]	-----	-----	[a]	-----
	p. m.	-----	[b]	-----	-----	[d]	-----	-----	[b]	-----	-----	[a]	-----

[a] Not mated. [b] Did not mate. [c] No spermatozoa in secretion. [d] Rest.

TABLE 2.—*Relative numbers of the three types of spermatozoa of boars mated once every day.*

Boar No.	June 21.			June 22.			June 23.		
	I	II	III	I	II	III	I	II	III
2564/34	-----	[a]	-----	500	-----	-----	500	-----	-----
2615/91	498	2	-----	500	-----	-----	-----	[b]	-----
2805/330	-----	[a]	-----	362	121	17	452	42	6

Boar No.	June 24.			June 25.			June 26.		
	I	II	III	I	II	III	I	II	III
2564/34	500	-----	-----	500	-----	-----	495	5	-----
2615/91	500	-----	-----	500	-----	-----	-----	[b]	-----
2805/330	490	10	-----	500	-----	-----	493	7	-----

[a] Not mated. [b] Did not mate.

TABLE 3.—*Relative numbers of the three types of spermatozoa in 10-month-old boars mated twice a day.*

Boar No.	Time of day.	June 28.			June 29.		
		I	II	III	I	II	III
2782/298	a. m.	477	4	19	-----	[d]	-----
	p. m.	-----	[b]	-----	-----	-----	-----
2705/194	a. m.	497	1	2	-----	[d]	-----
	p. m.	-----	-----	-----	-----	[d]	-----

[b] Did not mate. [d] Rest.

TABLE 3.—*Relative numbers of the three types of spermatozoa in 10-month-old boars mated twice a day*—Continued.

Boar No.	Time of day.	June 30.			July 1.			July 2.		
		I	II	III	I	II	III	I	II	III
2782/298	a. m.	484	7	9	------	(c)	------	------	(b)	------
	p. m.	480	4	16	------	------	------	------	(b)	------
2705/194	a. m.	489	------	11	------	(c)	------	------	(b)	------
	p. m.	494	------	6	------	------	------	------	(b)	------

[b] Did not mate. [c] Rest.

The counts were made from three slides prepared from the samples of semen soon after collection. The slides, made from semen well shaken and mixed, may be considered as constituting a good random sample of semen. From the spermatozoa in the preparations a random sample of 500 spermatozoa was taken. As each spermatozoon was come upon, it was classified according to type. In this manner the relative numbers of each of the three types were determined.

Tables 1 to 3 give the relative numbers of the three types of spermatozoa in the semen of boars under different intensivenesses of mating. Table 1 may be said to give the highest degree of intensiveness of mating. The boars in Table 1 being mated twice a day every other day did within twelve hours during the day of mating the work that the boars in Table 2 did in two days. As a general rule, the boars in Table 1, by doing the work at a faster rate, tired faster and took more time to get rested than the boars in Table 2. Moreover, at least in the case of boars 2485/27 and 2486/28, there were eight matings in the course of seven days or an average of over one mating a day; those in Table 2 mated only five times in as many days. Boar 2615/91 took five days for four matings.

As has been noted above, because the demand for spermatozoa is greatly increased during intensive mating over that during light mating, the relative proportion of types II and III to type I in the semen should increase, especially during the later part of an intensive-mating period. Tables 1 to 3 fail to satisfy this expectation. Table 1 shows instead, if anything, a tendency for the number of types II and III to decrease.

The tables further show that the different boars seem to possess different abilities to produce these different types. Boars 2564/34 and 2200/91 contrast in this respect. The former pro-

duced few of either type II or III—less than 0.5 per cent; on the other hand, boar 2200/91 is interesting in that his semen contained at one time a preponderance of type II over either type I or III, and even over both. The other boars examined show type I preponderating overwhelmingly over both types II and III.

The condition of the preponderance of type II over types I and III in the semen of boar 2200/91, July 3 and 5, was, however, a temporary condition, as Table 4 shows.

TABLE 4.—*Relative numbers of the three types in the semen of boar 2200/91 at different dates.*

Date.	Type.			Total spermatozoa.
	I	II	III	
July 3	130	302	68	1.83×10^{10}
July 5	165	261	74	239×10^{10}
August 15	477	11	12	11.07×10^{10}

In the case of this boar, at least, the big production of types II and III is associated with a small production of spermatozoa. July 3, even after a rest of thirteen days from his last mating, the boar gave only 1.83 by 10^{10} spermatozoa, and July 5, 2.39 by 10^{10}, almost double his production two days before, whereas August 15, after a rest of thirteen days, he gave 11.07 by 10^{10} spermatozoa. July 3 and 5, when the boar produced an abnormally small number of spermatozoa, types II and III were abnormally numerous, type II even predominated over types I and III. August 15, however, when he produced a normal number of spermatozoa, the relative number of types II and III was small. It would seem, therefore, as if the ejection of large numbers of types II and III were correlated with the production of abnormally small numbers of spermatozoa. In that case it is not improbable that the ejection of large numbers of types II and III is in some way due to an abnormal physiological condition in the boar.

This consideration raises the question of whether types II and III are abnormal. There are two facts that seem to contradict the idea that they are abnormal. First, their longevity is not less than that of type I. They have been observed actively and normally moving thirty-two hours after the collection of the semen, which was kept at 15° C. This is about as long as any type will live in vitro in undiluted semen at 15° C.

Second, abnormal products usually assume different shapes. As will presently be shown, measurements taken of the different types tend to show them to be distinct from one another and of little variability.

(*b*) *Measurements of the spermatozoa.*—Three hundred of each of the three types have been measured from the preparations by means of the ocular micrometer. The total length and the length and width of the head were the dimensions taken. In addition to these the distance from the tip of the acrosome to the "drop" was also taken in the case of type II. The individual spermatozoa measured were taken at random. The only selecting done was in picking out the individuals that were fairly straight; curled ones could not be measured accurately. The statistical treatment of the measurements is summarized in Table 5.

TABLE 5.—*Measurements of the three types of spermatozoa of the boar.*

Type.	Total length.		Distance from acrosome to "knob."	
	M. μ	S. D.	M. μ	S. D.
I	51.69±0.095	2.46±0.067		
II	50.93±0.084	2.16±0.059		
III	52.27±0.065	1.68±0.046	15.42±0.039	1.015+0.028

Type.	Head.			
	Length.		Breadth.	
	M. μ	S. D.	M. μ	S. D.
I	8.018±0.022	0.555±0.015	4.20±0.013	0.328±0.009
II	7.788±0.019	0.473±0.013	4.04±0.014	0.361±0.010
III	8.047±0.019	0.500±0.014	4.26±0.012	0.307±0.008

TABLE 6.—*Differences between the means of the three types of spermatozoa of the boar.*

Type.	Total length.	Head.	
		Length.	Breadth.
I–II	51.69—50.93 = 0.76± 0.128	8.913—7.788= 0.225±0.029	4.20—4.04 = 0.16±0.019
III–II	52.27—50.93 = 1.34± 0.106	8.047—7.788= 0.259±0.027	4.26—4.04 = 0.22±0.018
III–I	52.27—51.69 = 0.58± 0.116	8.047—8.013= 0.034±0.029	4.26—4.20 = 0.06±0.017

Table 6, in which the significance of differences among the respective means are tested, shows that all the differences, except one—the exception being the difference between the length of head of types III and I—being more than three times their respective probable errors, may be considered at least almost certainly significant. According to the results type II is the smallest, type III the largest, and type I intermediate. Of course, the number measured is relatively small, and the smallness of the sample might invalidate the results obtained; but if each one of the samples could be considered a random sample the smallness of the numbers would not invalidate the results.

The results of the measurements are somewhat unexpected. If type II be the primitive type, as the evidence tends to show, then being the relatively undifferentiated type, it should be the largest; for some energy must be consumed in the process of differentiation, which would tend to reduce the size of the cells—unless the source of the energy needed for differentiation should be entirely of extra-cellular origin. There may possibly exist a mechanism that predestines the development of each spermatid into a particular type.

At all events, the evidence tends to show that these three types differ from one another not only in the absence or presence of a protoplasmic drop and on the position assumed by such a drop on the tail, but also in size. Furthermore, the variability of the different types is quite small, as gauged by their respective standard deviations.

There is no intergrading between types II and III. In other words, the protoplasmic drop seems to be either on the neck or towards the middle of the tail, but not in between. It seems then that there is no transformation from type II to type III in the semen; for were such a transformation taking place in the semen it should be possible to demonstrate it by showing that the curve of distribution of the protoplasmic drop is more or less a flat curve. The standard deviation of the measurement of the distance between the acrosome and the protoplasmic drop in type III would be large, and the position of the drop should vary all the way from the neck, its position in type II, to about the middle of the tail, its position in type III—which does not happen to be the case.

SUMMARY

1. The three types of spermatozoa observed in the semen of the boars studied represent morphological stages in their development. They differ from one another by the absence or presence of a protoplasmic drop and by the position assumed by the drop on the tail. Type I has no protoplasmic drop, type II has the drop on the neck, and type III towards the middle of the tail.

2. The spermatozoa are transformed from type II, which they all are at the proximal portion of the epididymis to type III, and finally to type I which is ordinarily the predominating type in the semen. Not all are transformed to type I, however; some of types II and III remain untransformed.

The transformation in type is parallelled by a transformation in motility. Type II found in the proximal portion of the epididymis are all nonmotile.

3. The relative numbers of the three types is not greatly altered by intensive mating.

4. Measurements made of representatives of types I, II, and III, tend to show that these types differ significantly in dimensions from one another. Type II is the smallest, III the largest, and I intermediate.

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ILLUSTRATION

PLATE 1. The three types of spermatozoa formed in the semen of the boar.

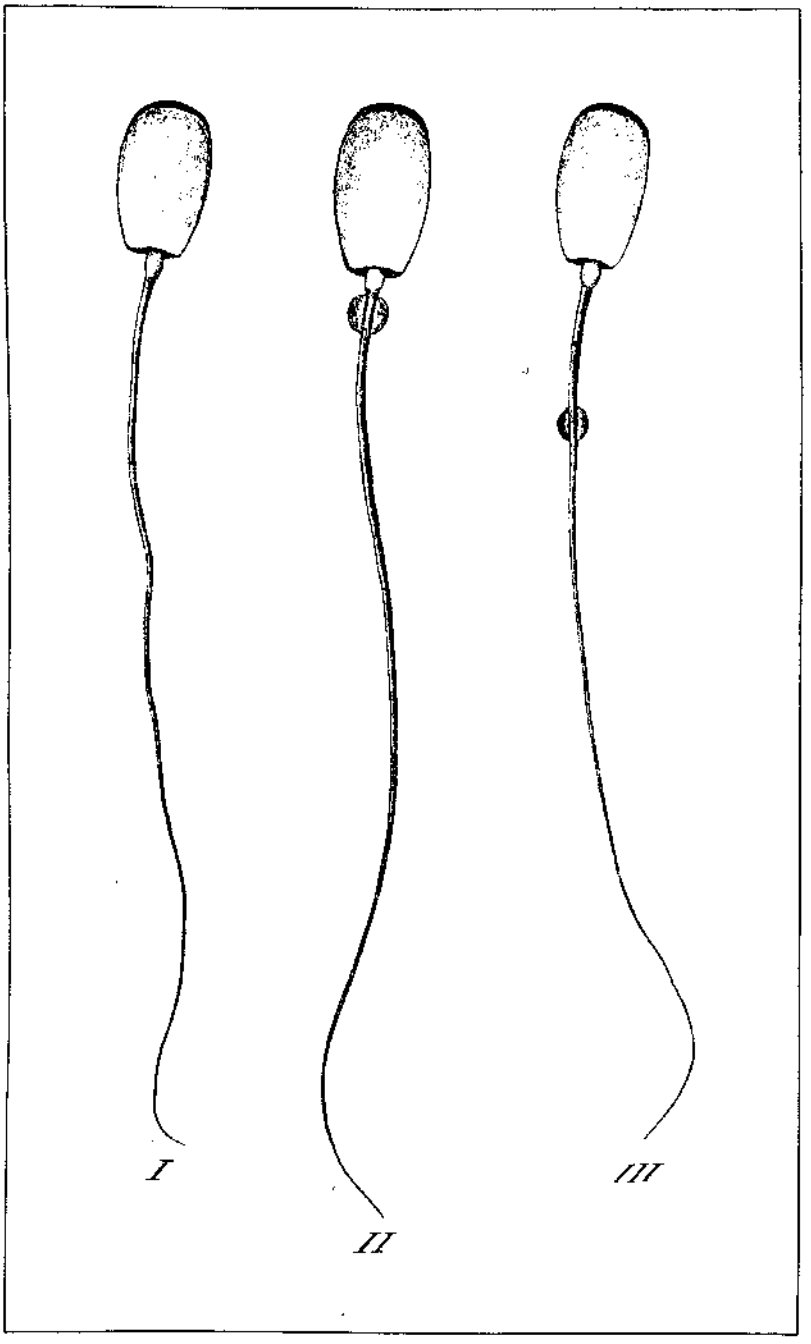

PLATE 1.

TANNIN CONTENT OF PHILIPPINE BARKS AND WOODS

By LUZ BAENS, F. M. YENKO, and AUGUSTUS P. WEST

Of the Bureau of Science, Manila

and

H. M. CURRAN

Of the Bureau of Forestry, Manila

ONE PLATE

During 1931 the value of the leather and leather articles imported into the Philippines [1] amounted to 2,166,301 pesos. There are a number of tanneries in the Philippines and a considerable amount of leather is produced locally. In most of the tanneries the methods employed for tanning hides are rather antiquated and consequently much of the leather manufactured locally is of poor quality and has a disagreeable odor.

The Philippine methods of tanning and the quality of leather produced could be greatly improved by experimentation. With proper development of the Philippine leather industry it would not be necessary to import considerable quantities of leather. All the leather that is required for local consumption could be manufactured in the Philippines and quite likely an export trade could also be developed.

The first step in the improvement of the leather industry is the investigation of the available local tanning materials in order to determine which materials have the highest tannin content and are most efficient and economical.

In the Philippines the materials commonly used, at present, for tanning hides are the barks of the kamachile tree [*Pithecolobium dulce* (Roxb.) Benth.] and various species of the mangrove (Rhizophoraceæ or mangrove family). Analyses of Philippine mangrove barks have been made by Bacon and Gana [2] and also by Williams.[3]

[1] Annual Report, Insular Collector of Customs, Manila (1933) 194.
[2] Philip. Journ. Sci. § A 4 (1909) 205.
[3] Philip. Journ. Sci. § A 6 (1911) 45.

In addition to mangrove Gana [4] also analyzed a few other Philippine barks. With the exception of kamachíle, these barks gave a rather low percentage of tannin and consequently the results were not promising.

Recently we determined the tannin content of a considerable number of Philippine barks and woods. Some of the barks were high in tannin and appeared to be of commercial value. Most of the woods, however, gave negative tests for tannin, although a few contained a very small amount.

The numerous samples of barks and woods selected for this investigation were taken, in general, from mature trees. Most of the trees were growing on Mount Maquiling near Los Baños in Laguna Province, though some were growing in other provinces.

Preparation of the samples for analysis consisted in first drying them in an oven at 60° C., for about twenty hours. The samples were then filed with a rasp and the filings sieved through a 20-mesh screen. The powder which passed through the sieve was used for the analysis.

Moisture determinations were made on the powdered samples and the results of the analyses were calculated on the moisture-free sample.

In analyzing the numerous samples we used a rapid method [5] for the determination of tannin. Results with high tannin barks were, however, checked by the official hide-powder method.

In Table 1 is given the tannin content of a considerable number of Philippine barks. As shown by the data some of them have a high percentage of tannin.

Kamachíle and the mangrove barks (bakáuan laláke, bakáuan babáe, tañgál, potótan, busáin, and lañgarai) are used for tanning and naturally were found to have a considerable amount of tannin.

Samples of other barks (Table 1), which gave a high percentage of tannin, were analyzed by the official hide-powder method in the laboratory of the Philippine Cutch Corporation of Zamboanga through the courtesy of the manager, Mr. Geo. A. Kerr. The results are given in Table 2.

Pieces of hides were tanned very satisfactorily with infusions of these high-tannin barks. These tanning experiments were

[4] Philip. Journ. Sci. § A 10 (1915) 355.

[5] Baens, L., and A. P. West, Philip. Journ. Sci. 47 (1932) 467.

TABLE 1.—*Tannin content of Philippine barks.*

Sample. No.	Name of bark.		Tannin content.
	Common.	Scientific.	
			Per cent.
1	Bagtikan	*Parashorea malaanonan* (Blco.) Merr	3.60
6	Anabióng	*Trema orientalis* (L.) Bl	17.10
7	Antipólo	*Artocarpus blancoi* (Elmer) Merr	5.30
8	Balinhásai	*Buchanania arborescens* Bl	11.10
9	Dúhat	*Eugenia cumini* (L.) Druce	0.90
10	Kalúmpit	*Terminalia edulis* Blco	42.60
11	Sakat	*Terminalia nitens* Presl	27.38
12	Santól	*Sandoricum koetjape* (Burm. f.) Merr	11.80
13	White lauan	*Pentacme contorta* (Vid.) Merr. and Rolfe	5.50
14	Bitaog	*Calophyllum inophyllum* L	19.12
15	Talúto	*Pterocymbium tinctorium* (Blco.) Merr	10.20
16	Moláve	*Vitex parviflora* Juss	trace
17	Anónang	*Cordia dichotoma* Forst. f	1.80
18	Magílik	*Premna cumingiana* Schauer	none
19	Balákat	*Zizyphus talanai* (Blco.) Merr	none
20	Aiafigile	*Acacia confusa* Merr	5.60
21	Agáru	*Dysoxylum decandrum* (Blco.) Merr	none
22	Abúab	*Lophopetalum toxicum* Loher	trace
23	Dapdáp	*Erythrina variegata* L	none
24	Binúnga	*Macaranga tanarius* (L.) Muell.-Arg	2.10
25	Himbabáo	*Allaeanthus luzonicus* (Blco.) F.-Vill	trace
26	Liúsin	*Parinarium corymbosum* (Bl) Miq	6.82
27	Vidal's lanútan	*Bombycidendron vidalianum* (Naves) Merr. and Rolfe.	none
28	Tuái	*Bischofia javanica* Bl	trace
29	Sablót	*Litsea glutinosa* (Lour.) C. B. Rob	0.60
30	Kaliantan	*Leea manillensis* Walp	11.80
31	Ákle	*Albizzia acle* (Blco.) Merr	1.80
32	Hauili	*Ficus hauili* Blco	none
33	Tibig	*Ficus nota* (Blco.) Merr	1.10
34	Malarúhat	*Eugenia similis* Merr	4.20
35	Láñgil	*Albizzia lebbeck* (L.) Benth	6.50
36	Rosewood	*Dalbergia sissoo* Roxb	1.00
37	Binúang	*Octomeles sumatrana* Miq	2.60
38	Guava	*Psidium guajava* L	11.30
39	Kúpang	*Parkia javanica* (Lam.) Merr	20.50
40	Mango	*Mangifera indica* L	9.40
41	Kariskis	*Pithecolobium subacutum* Benth	21.90
42	Kamachíle	*Pithecolobium dulce* (Roxb.) Benth	30.10
43	Banabá	*Lagerstroemia speciosa* (L.) Pers	2.20
44	Bayok-bayokan	*Pterospermum niveum* Vid	9.80
45	Caudate leaf oak	*Quercus philippinensis* A. DC	7.70
46	Kalamansánai	*Neonauclea calycina* (Bartl.) Merr	trace
47	Kulatifigan	*Pterospermum obliquum* Blco	19.00
48	Lamóg	*Planchonia spectabilis* Merr	4.50
49	Pagsahifigin	*Canarium villosum* (Bl.) F.-Vill	0.20
50	Bakáuan babáe	*Rhizophora mucronata* Lam	28.50
51	Bakáuan laláke	*Rhizophora candelaria* DC	20.20
52	Potótan	*Bruguiera sexangula* (Lour.) Poir	24.50

TABLE 1.—*Tannin content of Philippine barks*—Continued.

Sample No.	Name of bark.		Tannin content.
	Common.	Scientific.	
			Per cent.
56	Busáin	*Bruguiera conjugata* (L.) Merr.	30.70
58	Lafigarai	*Bruguiera parviflora* (Roxb.) W and A.	25.00
60	Tafigál	*Ceriops tagal* (Perr.) C. B. Rob.	27.20
63	Dalinsi	*Terminalia pellucida* Presl.	17.80
64	Akleng-parang	*Albizzia procera* (Roxb.) Benth.	14.60
106	Indian rosewood	*Dalbergia latifolia* Roxb.	none
107	Ipil	*Intsia bijuga* (Colebr.) O. Ktze.	4.60
108	Talisai	*Terminalia catappa* L.	1.70
112	Javanese cañafistula	*Cassia javanica* L.	6.30
113	Kalantás	*Toona calantas* Merr. and Rolfe.	1.60
115	Baringbing	*Peltophorum inerme* (Roxb.) Llanos.	11.50
117	Tabigi	*Xylocarpus granatum* Koen.	22.50
119	Teak	*Tectona grandis* L. f.	none
137	Black wattle	*Acacia decurrens* Willd.	42.50

TABLE 2.—*Analysis of Philippine tanbarks of high tannin content.*[a]

Bark.	Tannin.	Non-tannin.	Solids.		
			Total.	Soluble.	Insoluble.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kalúmpit; *Terminalia edulis* Blco.	34.11	7.23	43.17	41.34	1.83
Sakat; *Terminalia nitens* Presl.	19.46	6.49	28.66	25.95	2.71
Kariskis; *Pithecolobium subacutum* Benth.	19.70	7.63	28.12	27.33	0.79
Kúpang; *Parkia javanica* (Lam.) Merr.	18.07	8.37	27.82	26.44	1.38
Bitaog; *Calophyllum inophyllum* L.	16.05	4.96	22.68	21.01	1.67
Black wattle; *Acacia decurrens;* thickness of bark:					
1/16 inch	.3	10.72	40.16	39.15	1.01
1/4 inch	45.80	10.60	56.80	56.18	0.62
1/4 inch	45.05	10.73	56.58	55.78	0.80
5/16 inch	45.79	10.75	57.28	56.54	0.74

[a] Analysis made under the direction of Mr. Geo. A. Kerr in the laboratory of the Philippine Cutch Corporation of Zamboanga.

carried out in our laboratory and also in the laboratory of the Philippine Cutch Corporation at Zamboanga.

In his report to us Mr. Kerr writes as follows:

The sample of kalúmpit bark (Table 2) contains sufficient tannin to indicate that it may be commercially valuable for the manufacture of tannin extract or for direct use in the tannery. The bark samples of

sakat, kariskis, kúpang, and bitaog may be suitable for direct use in the tannery but the tannin content is not high enough to warrant utilization for making tannin extract.

The black wattle bark gave the highest tannin content (Tables 1 and 2) of all the barks we analyzed. This bark was obtained from trees grown in Bukidnon Province, Mindanao. In the place (sitio) called Kaatoan these trees reached an average height of 5.29 meters in about four years. They were cultivated from seeds that were obtained from the Forest Research Institute, Buitenzorg, Java.

Concerning the analysis and commercial value of the Philippine black wattle bark grown in Bukidnon, Mr. Kerr says:

> This bark compares most favorably with the native black wattle bark of Australia and also the plantation bark of Natal and Kenya Colonies, Africa. In fact, the tannin content is considerably higher than the average in those countries and the nontannin content is also good. The color and tannage is about equal to any other bark we have examined. There is no question that, if bark like this could be grown in Bukidnon, there is a very great future for it. Although wattle bark is not used in America to any great extent it is very extensively imported into Europe and Great Britain where, at present, the normal price is from $35 to $40 per ton of dry bark.

Mr. Arthur F. Fischer, director of the Philippine Bureau of Forestry, informs us that in some districts in Bukidnon the black wattle tree grows very well and it is quite likely that these trees could be cultivated successfully on rich soil where the climate is similar to that of Bukidnon.

Since 1824 black wattle bark has been used in Australia and Tasmania as tanning material.[6] It was introduced into Natal, South Africa, about 1864. It is now cultivated in other districts in Africa and is considered one of the richest tanning materials known. The bark gives an infusion of good color so that the resulting leather is very light and has only a faint pinkish tinge. Owing to the high proportion of tannin it is a cheap tanning material and the bark can be stored a long time without any appreciable deterioration. Specimens of bark stored in the Sydney Technological Museum for thirty years were analyzed before and after storage. The results showed practically no diminution in the tannin content.

[6] Williams, C. O., Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

C. O. Williams [7] made a very thorough investigation of the black wattle trees grown in the Wartburg district of Natal, South Africa. These trees gave a fairly good yield of bark. Unfertilized trees (four and a half years old) gave 3.23 tons of green bark per acre while well-fertilized trees gave 5.04 tons.

Black wattle trees (four years old) produced in Natal, Africa, a bark containing 31.5 per cent of tannin, while in the Philippines the bark had 45 per cent. From this it appears that, under favorable growing conditions, black wattle bark gives a higher yield of tannin in the Philippines than in Africa.

The development of Philippine plantations of black wattle trees would seem to offer promising prospects. After stripping the trees of the bark the wood that remains may be used for various purposes. According to C. O. Williams [8] the chief by-product of the wattle-bark industry in Natal, Africa, is the wood. He estimated that out of the total receipts from an ordinary Natal wattle plantation, about 56 per cent was derived from the sale of the bark, 33 per cent from mine props, and 11 per cent from fuel wood. It is therefore realized that the timber in itself is a valuable source of income as compared with that derived from the bark. He says it would be difficult to find any tanning material that could be produced in South Africa in such quantity and at such low cost as to compete successfully with wattle bark.

In Table 3 is given the percentage of tannin in some Philippine barks obtained from different localities. As shown by the data the tannin content of the bark from trees of the same species grown in different districts varies considerably. In the report of his work on Philippine mangrove barks R. R. Williams [9] states:

> It has further been observed that, in general, the tannin content of the bark increases with the size of the tree. It is probable that the age rather than the size of the tree is the true coefficient of the tannin content but since these trees show no seasonal rings of growth it is almost impossible more than roughly to approximate the age.

[7] Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

[8] Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932) 62 and 88.

[9] Philip. Journ. Sci. § A 6 (1911) 45.

TABLE 3.—*Tannin content of some Philippine barks from different localities.*

Sample No.	Name of bark.		Place of collection.	Tannin content.
	Common.	Scientific.		
				Per cent.
99	Anabiông	*Trema orientalis* (L.) Bl	Alisongsong Lallo, Cagayan	23.20
53	do	do	Tayabas	9.50
77	do	do	Cabanatuan, Nueva Ecija	10.70
91	do	do	Masinloc, Zambales	31.90
93	do	do	Subic, Zambales	6.50
71	do	do	Hermosa, Bataan	10.60
73	do	do	Limay, Bataan	11.20
6	do	do	Los Baños, Laguna	17.10
64	Bakáuan babáe	*Rhizophora mucronata* Lam	Tayabas	18.00
131	do	do	Puerto Princesa, Palawan	11.80
109	do	do	Palawan	22.50
65	Bakáuan lalâke	*Rhizophora candelaria* DC	Tayabas	16.00
132	do	do	Puerto Princesa, Palawan	9.20
110	do	do	Palawan	17.90
103	Bitaog	*Calophyllum inophyllum* L	Jurisdiction Lallo, Cagayan	16.50
65	do	do	Pangasinan	16.20
82	do	do	Vigan Forest Station, Ilocos Sur.	5.30
92	do	do	Masinloc, Zambales	11.60
94	do	do	Subic, Zambales	17.30
121	do	do	Limay, Bataan	9.00
14	do	do	Los Baños, Laguna	19.12
66	Busáin	*Bruguiera conjugata* (L.) Merr.	Tayabas	30.70
133	do	do	Puerto Princesa, Palawan	12.60
111	do	do	Palawan	19.30
56	Kalúmpit	*Terminalia edulis* Blco	Pangasinan	16.10
83	do	do	Vigan Forest Station, Ilocos Sur.	22.50
88	do	do	Bayombong, Nueva Vizcaya	25.90
62	do	do	Tayabas	24.80
78	do	do	Cabanatuan, Nueva Ecija	36.20
95	do	do	Subic, Zambales	32.10
124	do	do	Masinloc, Zambales	11.40
72	do	do	Hermosa, Bataan	23.30
74	do	do	Limay, Bataan	11.70
10	do	do	Los Baños, Laguna	42.00
70	Kamachîle	*Pithecolobium dulce* (Roxb.) Benth.	Bucay, Abra	35.20
67	do	do	Pangasinan	33.00
89	do	do	Bayombong, Nueva Vizcaya	30.20
57	do	do	Tayabas	25.20
79	do	do	Cabanatuan, Nueva Ecija	37.20
125	do	do	Masinloc, Zambales	16.00
96	do	do	Subic, Zambales	12.20
122	do	do	Limay, Bataan	20.40
42	do	do	Los Baños, Laguna	30.10

TABLE 3.—*Tannin content of some Philippine barks from different localities*—Continued

Sample No.	Name of bark.		Place of collection.	Tannin content
	Common.	Scientific.		
				Per cent.
104	Kariskis	*Pithecolobium subacutum* Benth.	Naguilian Lallo, Cagayan	27.70
68	do	do	Pangasinan	6.80
80	do	do	Cabanatuan, Nueva Ecija	23.50
126	do	do	Masinloc, Zambales	5.20
97	do	do	Subic, Zambales	10.60
41	do	do	Los Baños, Laguna	21.90
100	Kulatiñgan	*Pterospermum obliquum* Blco.	Alisongsong Lallo, Cagayan	16.70
86	do	do	Caniaw, Bantay, Ilocos Sur	28.80
61	do	do	Tayabas	7.20
75	do	do	Limay, Bataan	27.60
47	do	do	Los Baños, Laguna	19.00
129	Kúpang	*Parkia javonica* (Lam.) Merr.	Mount Banahaw, Tayabas	9.70
127	do	do	Masinloc, Zambales	12.70
98	do	do	Subic, Zambales	6.50
123	do	do	Limay, Bataan	21.40
39	do	do	Los Baños, Laguna	20.50
58	Lañgarai	*Bruguiera parviflora* (Roxb.) W. and A.	Tayabas	25.00
134	do	do	Puerto Princesa, Palawan	11.50
114	do	do	Palawan	13.10
59	Potótan	*Bruguiera sexangula* (Lour.) Poir.	Tayabas	20.50
135	do	do	Puerto Princesa, Palawan	18.90
116	do	do	Palawan	18.90
101	Sakat	*Terminalia nitens* Presl	Alisongsong Lallo, Cagayan	14.60
102	do	do	Aggutan Gattara, Cagayan	27.60
69	do	do	Pangasinan	18.70
84	do	do	Vigan Forest Station, Ilocos Sur.	9.50
90	do	do	Bayombong, Nueva Vizcaya	44.00
128	do	do	Masinloc, Zambales	22.00
120	do	do	Hermosa, Bataan	29.50
130	do	do	Maligaya Unisan, Tayabas	12.80
81	do	do	Cabanatuan, Nueva Ecija	21.80
76	do	do	Limay, Bataan	33.50
11	do	do	Los Baños, Laguna	27.38
60	Táñgal	*Ceriops tagal* (Perr.) C. B. Rob.	Tayabas	27.20
136	do	do	Puerto Princesa, Palawan	27.50
118	do	do	Palawan	28.10

In the Wartburg district[10] of Natal, South Africa, the average tannin content of black wattle bark from trees 2 years old

[10] Williams, C. O., Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

was found to be 26.3 per cent and from trees 12 years old it was 39.8 per cent. Ten years in the age of these trees increased the average tannin content of the bark only 13.5 per cent.

According to our data (Table 3) a bark of a certain species may give a rather high percentage of tannin in one province and a very low percentage in another. Since the barks used for these analyses had about the same thickness this difference in tannin content is too great to be due only to the age of the bark. Apparently the local environmental conditions of tree growth affect considerably the tannin content of the bark.

Our results (Table 3) are interesting for they indicate certain places that are very suitable for growing trees with high-tannin bark. For instance anabióng (sample 91), grown in Masinloc, Zambales, produces bark with a higher-tannin content (31.9 per cent) than when grown in other locations. Anabióng is a fast-growing tree and reaches a diameter of about 10 centimeters in two years. It requires very little labor to obtain the bark as it is easily removed from the tree, and consequently it might be profitable to cultivate anabióng in Zambales.

Kalúmpit bark gave a tannin content of 42 per cent when the trees were grown at Los Baños, Laguna. Sakat bark, grown at Bayombong, Nueva Vizcaya, had 44 per cent of tannin. These barks gave a much lower tannin content when the trees were grown in other districts.

In order to ascertain the most desirable places for growing trees with high-grade tanbark, it would be advisable to cultivate the trees in various locations in the different provinces.

The simplest classification of tannins divides them into two main groups—pyrogallol and catechol tannins. These two classes of tannins may be distinguished by their reactions with certain chemical reagents such as ferric chloride, sulphuric acid, bromine water, and lead acetate with the subsequent addition of acetic acid.

We tested the high-tannin barks for the kind of tannin contained in them. Extracts of black wattle, kariskis, kulatiñgan, bitaog, anabióng, kamachíle, tabígi, and the mangrove barks, gave reactions characteristic of catechol tannins. The dalinsi extract contained pyrogallol tannins. Infusions of kalúmpit, sakat, and kúpang, contained principally pyrogallol tannins, though they also had small amouts of catechol tannins.

A considerable number of Philippine woods were analyzed for their tannin content. Most of the woods gave negative results or only traces of tannin. A few, however, were found to have

small amounts of tannin. The names of woods which contained tannin are given in Table 4, and in Table 5 are given the names of those which gave negative results or only traces of tannin.

TABLE 4.—*Tannin content of some Philippine woods.*

Sample. No.	Name of wood.		Tannin content.
	Common.	Scientific.	
			Per cent.
19	Lamõg	*Planchonia spectabilis* Merr	0.50
23	Biñgas	*Terminalia comintana* (Blco.) Merr	1.40
25	Bayók	*Pterospermum diversifolium* Bl	2.20
33	Palong manok	*Alangium chinense* (Lour.) Rehder	0.80
43	Apitong	*Dipterocarpus grandiflorus* Blco	0.30
45	Oak	*Quercus bennettii* Miq	0.50
53	Kalúmpit	*Terminalia edulis* Blco	2.90
82	Bitoñgol	*Flacourtia rucam* Zoll. and Merr	1.90
90	Dúñgon-láte	*Heritiera littoralis* Dry	2.10
92	Tañgile	*Shorea polysperma* (Blco.) Merr	1.80
118	Javanese cañafistula	*Cassia javanica* L	1.20

In addition to our experiments on tanbarks and woods we have also tested some green (unripe) fruits for their tannin content. We found two fruits that seemed to offer promising prospects for making commercial tannin extract. The fruit of sakat (*Terminalia nitens*) gave 29.57 per cent of tannin. Tanning experiments with the extract of this fruit gave about the same results as those obtained with the extract of the fruit of myrobalan (*Terminalia chebula*) which is considered a very good tanning material and contains about 30 to 40 per cent of tannin. The kernels of some betel nuts [11] gave 26.89 per cent of tannin. The extract from these kernels appeared to be excellent tanning material and gave leather which had a pale cream color. We intend to make tanning tests on the various species of betel nuts and other Philippine fruits when time permits.

We are now preparing to install in the Bureau of Science a miniature tannin extract plant and tannery. We expect to make extracts from the more promising Philippine tanbarks and fruits and to use these extracts for making leather according to the modern technique of tanning. The operation of these plants and the results obtained should be of very practical value to

[11] *Areca catechu* L. Varietal determination was not made for lack of botanical material.

TABLE 5.—*Philippine woods which contain no tannin or only traces of tannin.*

Sample No.	Name of wood.	
	Common.	Scientific.
1	Bagtíkan	*Parashorea malaanonan* (Blco.) Merr.
7	Bolonĝéta	*Diospyros pilosanthera* Blco.
8	Balakat-gúbat	*Sapium luzonicum* (Vid.) Merr.
9	Santól	*Sandoricum koetjape* (Burm. f.) Merr.
10	Anúbing	*Artocarpus cumingiana* Trec.
11	Balákat	*Zizyphus talanai* Blco.
12	Balóbo	*Diplodiscus paniculatus* Turcz.
13	Malaikmo	*Celtis philippinensis* Blco.
14	Alupág	*Euphoria cinerea* Radlk.
15	Banai-bánai	*Radermachera pinnata* (Blco.) Seem.
16	Dulit	*Canarium multipinnatum* Llanos.
17	Benguet pine	*Pinus insularis* Endl.
20	Kayatau	*Dysoxylum turczaninowii* C. DC.
21	Kariskis	*Pithecolobium subaculum* Benth.
22	Lago	*Pygeum vulgare* (Koehne) Merr.
24	Bayánti	*Aglaia llanosiana* C. DC.
26	Kulatiñgan	*Pterospermum obliquum* Blco.
27	Bolon	*Alphonsea arborea* (Blco.) Merr.
28	Balsa	*Ochroma lagopus* Schwartz.
29	Nárra	*Pterocarpus indicus* Willd.
30	Ilang-ilang	*Canangium odoratum* (Lam.) Baill.
31	Anabióng	*Trema orientalis* (L.) Bl.
32	Fire-tree	*Delonix regia* (Boj.) Raf.
34	Alím	*Melanolepis multiglandulosa* (Reinw.) Reichb. f. and Zoll.
35	Baguilúmbang	*Aleurites trisperma* Blco.
36	Gúbas	*Endospermum peltatum* Merr.
37	Lúmbang	*Aleurites moluccana* (L.) Willd.
38	Malapapáya	*Polycias nodosa* (Bl.) Seem.
39	Rain tree	*Samanea saman* (Jacq.) Merr.
40	Basikong	*Ficus conora* King.
41	Binuñga	*Macaranga tanarius* (L.) Muell.-Arg.
42	Tibig	*Ficus nota* (Blco.) Merr.
44	Gatásan	*Garcinia venulosa* (Blco.) Choisy.
46	Camagón	*Diospyros discolor* Willd.
47	Tanglín	*Adenanthera intermedia* Merr.
48	Tináan-pantái	*Cyclostemon bordenii* Merr.
49	Amúgis	*Koordersiodendron pinnatum* (Blco.) Merr.
50	Narig	*Vatica manggachapoi* Blco.
51	Tuái	*Bischofia javanica* Bl.
52	Kalúkoi	*Ficus malunuensis* Warb.
54	Tamayuán	*Strombosia philippinensis* (Baill.) Rolfe.
55	Bayok-bayókan	*Pterospermum niveum* Vid.
56	Gisok	*Shorea balangeran* (Korth.) Dyer.
57	Salakín	*Aphanamixis cumingiana* (C. DC.) Harms.
58	Terukan	*Beilschmiedia glomerata* Merr.
59	Butli	*Ficus maulensis* Warb.
60	Biñgábing	*Macaranga grandifolia* (Blco.) Merr.
61	Sanglai	*Ahernia glandulosa* Merr.
62	Hamingdáng	*Macaranga bicolor* Muell.-Arg.
63	Ibaibáan	*Glochidion philippicum* (Cav.) C. B. Rob.
64	Apanang	*Neotrewia cumingii* (Muell.-Arg.) Pax and Hoffm.

TABLE 5.—*Philippine woods which contain no tannin or only traces of tannin*—Continued.

Sample No.	Name of wood.	
	Common.	Scientific.
65	Pakíling	*Ficus odorata* (Blco.) Merr.
66	Katong-maching	*Chisocheton pentandrus* (Blco.) Merr.
67	Iloilo	*Aglaia iloilo* (Blco.) Merr.
68	Malasangki	*Euonymus javanicus* Bl.
69	Tañgisang-bayáuak	*Ficus variegata* Bl.
70	Náto	*Palaquium luzonicnse* (F.–Vill.) Vid.
71	Kamátog	*Erythrophlocum densiflorum* (Elm.) Merr.
72	Guijo	*Shorea guiso* (Blco.) Bl.
73	Mangachapuy	*Hopea acuminata* Merr.
74	Palosápis	*Anisoptera thurifera* (Blco.) Bl.
75	Raráng	*Erythrina subumbrans* (Hassk.) Merr.
76	Tambalau	*Knema glomerata* (Blco.) Merr.
78	Villamil's nato	*Sideroxylon villamilii* Merr.
79	Pahútan	*Mangifera altissima* Blco.
80	Bugáuak	*Evodia confusa* Merr.
81	Tanghau	*Antrocalyx calycina* (Vid.) Merr.
83	Lanútan	*Polyalthia rumphii* (Bl.) Merr.
84	Balitahan	*Bridelia glauca* Bl.
85	Malanángka	*Parartocarpus woodii* (Merr.) Merr.
86	Almon	*Shorea eximia* (Miq.) Scheff.
87	White lauan	*Pentacme contorta* (Vid.) Merr. and Rolfe.
88	Yakál	*Hopea plagata* (Blco.) Vid.
89	Mayápis	*Shorea palosapis* (Blco.) Merr.
91	Malúgai	*Pometia pinnata* Forst.
93	Ákle	*Albizzia acle* (Blco.) Merr.
94	Bitaog	*Calophyllum inophyllum* L.
95	Banabá	*Lagerstroemia speciosa* (L.) Pers.
96	Ceara rubber	*Manihot glaziovii* Muell.–Arg.
97	Únik	*Albizzia chinensis* (Osbeck) Merr.
98	Ípil	*Intsia bijuga* (Colebr.) O. Ktze.
99	Indian rosewood	*Dalbergia latifolia* Roxb.
100	Lanete	*Wrightia laniti* (Blco.) Merr.
101	Láñgil	*Albizzia lebbeck* (L.) Benth.
102	Liúsin	*Parinarium corymbosum* (Bl.) Miq.
103	Moláve	*Vitex parviflora* Juss.
104	Taiñgang babui	*Gonocaryum calleryanum* (Baill.) Becc.
105	Pagsahiñgin	*Canarium villosum* (Bl.) F.–Vill.
106	Pañgi	*Pangium edule* Reinw.
107	Sibukáu	*Caesalpinia sappan* L.
108	Talisai	*Terminalia catappa* L.
109	Tindalo	*Pahudia romboidea* (Blco.) Prain.
110	Aiañgile	*Acacia confusa* Merr.
111	Teak	*Tectona grandis* L. f.
112	Kalantás	*Toona calantas* Merr. and Rolfe.
113	Mahogany	*Swietenia mahagoni* Jacq.
114	Banúyo	*Wallaceodendron celebicum* Koord.
115	West Indian cedar	*Cedrela odorata* L.
116	Vidal's lanútan	*Bombycidendron vidalianum* (Naves) Merr. and Rolfe.
117	Baringbíng	*Peltophorum inerme* (Roxb.) Llanos.

those interested in the Philippine tanning industry and should serve to improve the quality of leather manufactured locally. Moreover the production of tannin extracts on a small commercial scale may eventually lead to an export trade in this industry.

In their reforestation work the Bureau of Forestry is planning to cultivate in certain districts trees with high-tannin bark.

SUMMARY

The tannin content of numerous Philippine barks was determined. Kamachíle and the mangrove barks (bakáuan babáe, bakáuan laláke, tañgal, potôtan, busáin, and lañgarai) are used for tanning and naturally were found to have a considerable amount of tannin.

Other barks which had a rather high percentage of tannin were kalúmpit, sakat, kariskis, kúpang, and bitaog. These barks may be suitable for direct use in the tannery, but, with the exception of kalúmpit, the amount of tannin is not high enough to warrant utilization for making tannin extract.

The black wattle bark gave the highest tannin content of all the barks we analyzed. Bark from trees four years old contained about 45 per cent of tannin. Excellent tannin extract may be made from this bark.

The black wattle tree grows well in Bukidnon and probably it could be cultivated successfully elsewhere in the Islands where the climate is similar to that of Bukidnon. The development of Philippine plantations of black wattle trees would seem to offer promising prospects. After stripping the trees of the bark the wood that remains may be used for various purposes, such as mine timber, fuel, and the manufacture of paper and charcoal.

When trees of the same species are grown in different localities the amount of tannin in the bark may vary a great deal. This difference in tannin content is often too great to be due only to the age of the bark. Apparently the local environmental conditions of tree growth affect considerably the tannin content of the bark. For certain tree species our results (Table 3) suggest some districts that are more suitable than others for producing high-tannin bark.

In order to ascertain the most desirable places for growing trees with high-grade tanbark it would be advisable to cultivate

the trees experimentally in various locations in the different provinces.

A considerable number of Philippine woods were tested for tannin. Although a few of these woods contained a small amount of tannin, most of them had no tannin or only traces of it.

We also investigated a few Philippine fruits. Sakat (*Terminalia nitens*) and some betel nuts gave very good tannin extracts.

We are preparing to install in the Bureau of Science a miniature tannin-extract plant and tannery. Extracts obtained from Philippine tanbarks and fruits will be used in making leather.

The Bureau of Forestry is planning to reforest certain districts with trees having bark of high-tannin content.

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The authors wish to express their thanks and appreciation to Mr. Geo. A Kerr, manager of the Philippine Cutch Corporation of Zamboanga, for assistance in ascertaining the commercial value of Philippine tanbarks.

To Mr. Mamerto D. Sulit, of the Philippine Bureau of Forestry, obligations are acknowledged for checking the scientific names of the barks and trees recorded in this paper.

ILLUSTRATION

PLATE 1

Black wattle tree (*Acacia decurrens*) grown in Bukidnon, Mindanao.
191

PLATE 1.

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THE PHILIPPINE PHALLOSTETHIDÆ, A DESCRIPTION OF A NEW SPECIES, AND A REPORT ON THE BIOLOGY OF GULAPHALLUS MIRABILIS HERRE.[1]

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FIVE PLATES AND THREE TEXT FIGURES

Herre (1925) erected the genus *Gulaphallus* (family Phallostethidæ) to accommodate two strange new fishes collected from the fresh-water mountain streams of central Luzon. These are *Gulaphallus eximius* and *G. mirabilis*. A year later the same author described another phallostethid, *Mirophallus bikolanus*, from specimens obtained from the fresh-water lakes of southern Luzon.

The writers now report another species of Phallostethidæ, *Gulaphallus amaricola* sp. nov., collected from the brackish water[2] about Manila Bay. Of the known species of Phallostethidæ this new form is the first that is not an inhabitant of fresh water. The presence of the spinous dorsal fin and the absence

[1] Data relating to the life history and habits of *Gulaphallus mirabilis* Herre were included in an undergraduate thesis presented for graduation in 1932, by Porfirio R. Manacop, for the degree of Bachelor of Agriculture, prepared in the Department of Entomology, College of Agriculture, University of the Philippines, under the direction of Dr. Deogracias V. Villadolid.

[2] Materials were obtained in two collections from the brackish sloughs near Fort San Antonio Abad, Manila Bay, in the neighborhood of Pasay, Rizal. The first collection was made by Drs. C. G. Manuel and D. V. Villadolid in the summer of 1927, and the second by the former in the summer of 1932.

of scales on the nape and opercles, place the animal in the genus *Gulaphallus*.

GULAPHALLUS AMARICOLA sp. nov. Plate 1, figs. 1, 1a, 2, 2a.

First dorsal, II; second dorsal, I, 4–5 (usually I, 4); anal, I, 14–16 (mostly I, 14). Scales in median lateral series 30 to 32 (counted from gill opening to base of caudal fin); scales from origin of second dorsal to anal, 5; scales from first dorsal to naked region of nape, 17 to 19. Head, nape, and opercle, naked. Dorsal profile slightly elevated, but ventral strongly convex in females.

Myotomes very evident; a fine median dark line on sides extending from upper lid of pectoral fin to caudal base; occiput black. A line of dark chromatophores runs along base of abdominal fringe and anal fin to caudal peduncle. Scales along middorsal line heavily lined with black chromatophores. Scales regularly arranged along lateral line.

Male (*Plate 1, figs. 1, 1a*).—Body strongly compressed and slender, gradually tapering posteriorly. Sexually mature fish vary from 2.0 to 2.5 centimeters in length. Dorsal fins placed far back, the first above the posterior half of anal, the second originating just above end of anal base. Depth 5.24 in length of body; head with pointed and projecting chin, and 7.24 in length of body; mouth small and nearly vertical, with two rows of fine, pointed teeth in each jaw. Teeth of outer row of upper jaw much larger and more regularly arranged than either the inner row or the teeth of lower jaw. Teeth of outer row of upper jaw become finer towards median line. Interorbital space flat and broader than eye diameter. Pectoral bases muscular; length of caudal fin about 1.5 times its depth. Priapium elongated and projecting slightly downwards. Two priapial appendages present. One of the ctenactinia is so markedly short and small that a casual observer might not notice its presence. It arises from the posterolateral side of the priapium just beneath the greatest curvature of the proximal end of the other, longer priapial appendage. This position makes it appear homologous with the ctenactinium of *Phenacostethus smithi* Myers (1928).

Posterior border of priapium lined with comblike (or finlike) projections which appear similar to those of *Neostethus lankesteri* Regan.

Pulvinulus shieldlike, smaller than eye, facing the side towards which appendages of priapium project. Vas deferens coiled

within posterior end of priapium, opening at tip of a curved end adjacent to the short ctenactinium. This bone, in all likelihood, guides the penislike structure during the act of copulation as in the case of *G. mirabilis.*

Female (*Plate 1, figs. 2, 2a*).—Similar to male except in the following: (*a*) Absence of priapial structure, (*b*) marked convexity of ventral region, (*c*) two tuftlike papillæ on each side of abdomen just below muscular base of pectoral fin, possibly vestiges of ventral fins. Regions around genital opening elevated; genital opening located ventrally along median line just below base of pectoral fins and posterior to anal opening. A membranous abdominal fringe extends from the groove below genital opening to base of anal fin.

Amaricola, a brackish-water inhabitant.

The above description is based on 127 specimens, 64 males and 63 females, all collected from the sloughs of Manila Bay in the neighborhood of Pasay, Rizal, Philippine Islands.

Types.—One male and one female in the zoölogical museum, College of Agriculture, University of the Philippines. Cotypes are also in the zoölogical museum.

Type locality.—Pasay, Rizal Province, Luzon Island, Philippine Islands.

On the average, *G. amaricola* is smaller than the other species of the Philippine phallostethids. Sexually mature specimens measure only 2.16 centimeters in length.

The taxonomic characters that justify the separation of *Gulaphallus amaricola* from the other known species of the genus are shown in the following table.

Characters.	*G. amaricola.*	*G. mirabilis.*	*G. eximius.*
Second dorsal	I, 4 (rarely I, 5)	I, 6	I, 6.
Anal	I, 14–16	I, 16 or 17	I, 14–16.
Pulvinulus	Present	Absent	Absent.
Scales in longitudinal series	30–32	36–38	56–58.
Scales, origin of 2d dorsal to hind end of anal.	5	9	14.
Predorsal scales	17–19	26	28.
Comblike projections at base of priapium.	Present	Absent	Absent.
Priapial appendage	Two ctenactinia, one very short, almost vestigial and pinlike.	Two ctenactinia, one slightly shorter and clawlike.	Two ctenactinia, one slightly shorter and hooklike but broad.

The number of scales in a lateral series in *G. mirabilis* was reported by Herre to be 36 to 38 from the type locality (Mount Ibo Creek, Bulacan). Our count from specimens collected from Molawin Creek, Laguna, showed, however, that the range was 32 to 35. This apparently overlaps to a slight extent the range of scales of *G. amaricola*, which is 30 to 32. However, *G. amaricola* cannot be identical with *G. mirabilis* of Molawin Creek because of the differences shown in the key below, and from the difference in the number of scales as follows:

	G. mirabilis.	*G. amaricola.*
Origin of 2d dorsal to end of anal	7	5
Origin of 2d dorsal to origin of anal	12	10
First dorsal to head	27–29	17–19

THE PHILIPPINE PHALLOSTETHIDÆ

The family Phallostethidæ comprises a group of fishes unique among the entire vertebrate fraternity. So far they are the only vertebrates which present structures not recognized until the discovery in 1913 by C. Tate Regan of one of its members, *Phallostethus dunckeri* from Johore, Malay Peninsula. Myers (1928) describes the unique characteristics of the Phallostethidæ as follows: "Pelvic fins reported as vestigial in the female and absent in the male, whilst below the head and throat of the latter was a most peculiar appendage containing the coiled vas deferens and the end of the intestine, together with a complicated skeletal system mostly of what appeared to be entirely new elements. This appendage, called by Regan the priapium, bore externally two long curved bones apparently used as clasping organs. These are the toxactinium and ctenactinium of his (Regan's) descriptions."

Dr. Carl L. Hubbs, in a letter to the senior author dated June 16, 1931, expressed the opinion that it is possible that the family Phallostethidæ to which *Gulaphallus mirabilis* Herre belongs is phylogenetically more nearly related to Percesoces than to Cyprinodontes. In the latter order the family Phallostethidæ is generally included. He says in part: ". . . A point that struck my attention was the mention that you had found that the eggs were attached by long filaments. This discovery confirms, though it can hardly be said to prove, Myers's contention that the Phallostethidæ are derivatives of the Percesoces rather than of the Cyprinodontes which lack egg filaments. Such filaments are developed in all Atherinidæ, so far as known, except in *Leuresthes*."

To date the known Philippine representatives of Phallostethidæ are only four and may be identified by the use of the following artificial key:

a^1. Spinous dorsal present; nape and opercles naked.
  b^1. Comblike projections from base of priapium present (in males). Inhabitant of brackish-water. Scales 30 to 32 in lateral series. *Gulaphallus amaricola* sp. nov.
  b^2. Comblike projections from base of priapium (in males) absent. Inhabitant of fresh-water streams.
    c^1. Scales 56 to 58 in lateral series..... *Gulaphallus eximius* Herre.
    c^2. Scales 36 to 38 lateral series..... *Gulaphallus mirabilis* Herre.
a^2. No spinous dorsal; nape and opercles scaly; scales 32 in lateral series. Inhabitant of fresh-water lakes..... *Mirophallus bikolanus* Herre.

Distribution of Philippine phallostethids.—With the exception of *G. amaricola* sp. nov. all the known members of the family Phallostethidæ are inhabitants of fresh-water bodies; *G. amaricola* is an inhabitant of the brackish water of the sloughs about Manila Bay.

Gulaphallus mirabilis Herre was originally reported and described from Ibo Creek, a tributary of Angat River, Bulacan Province, Luzon. This river empties into Manila Bay. This species is also found in large numbers in Molawin Creek, Laguna, which originates in Mount Maquiling, and, like Angat River, empties into Manila Bay, through Laguna de Bay and Pasig River.

Gulaphallus eximius Herre was originally described from specimens collected from a mountain stream at Santa Fe, Nueva Vizcaya Province, Luzon. This stream is a branch of Magat River emptying into the main stream, Cagayan River, which in turn empties into the open sea in the northern part of Luzon.

Mirophallus bikolanus Herre was described from specimens collected from Lake Bato, Camarines Sur, and from Lake Lanigay, Albay. Both of these provinces are in the southern part of Luzon. Both Lake Bato and Lake Lanigay are connected with tributaries of Bicol River which empties into San Miguel Bay of the China Sea.

Distribution of Gulaphallus mirabilis in Molawin Creek.—Surveys April 7 and 8, 1931, along Molawin Creek, showed that the fish occurred from within a kilometer from the mouth up to an elevation of about 70 meters. The absence of *Gulaphallus* beyond this altitude may be due to the presence in that part of the creek of a waterfall which is about 3 meters high. The absence of *Gulaphallus* at the mouth of Molawin Creek was due

probably to the water being shallow. The depth of the water was found to be about 30 centimeters, and the fish apparently avoids very shallow water. Observations on the habitat of *Gulaphallus* in Molawin Creek showed that they prefer deep, shaded, and quiet places. Another survey of the creek was made November 22, 1931, when the water of Laguna de Bay was at high tide. *Gulaphallus* was found at the mouth of the creek. The water at that time was about 1.5 meters deep.

It is not improbable that some of the *Gulaphallus* may be carried into Laguna de Bay by floods. Nevertheless, a great number apparently manage to remain in the creek, as shown by the fact that just after a flood collections made in the creek still yielded plenty of specimens. The fish probably take refuge in back eddies where the current is not strong enough to carry them along during the flood.

BREEDING HABITS

(*a*) *Manner of oviposition.*—Observations on the breeding habits of *G. mirabilis* were made in a glass aquarium of about 30 liters capacity, in which *Ceratophyllum demersum* Linnæus was kept. The bottom of the aquarium was covered with a thin layer of sand and gravel from Molawin Creek.

Four females carrying ripe eggs and two adult males were transferred into the aquarium. September 15, 1931, at about 8 a. m., one of the four females was observed swimming up and down the aquarium. Soon two to three eggs were seen arranged in a linear series in its oviduct. After a few minutes the fish was observed swimming slowly in a dorsolateral position, and then it rested close to a healthy stem of *Ceratophyllum.* This was followed by the vibration of the caudal half of the body and the subsequent jerky motion of the whole body followed by the extrusion of the eggs. As soon as each egg was extruded it attached itself automatically to the leaves or stems of *Ceratophyllum* by its adhesive threadlike processes. The eggs apparently did not receive parental care after oviposition.

(*b*) *Copulation* (*Plate 5, fig. 2*).—Five mature females and three mature males were placed in a balanced aquarium in the laboratory. Copulation was observed to occur at any time of the day throughout the breeding season.

Prior to copulation, the male usually darts around a female and snappily grips her with its toxactinium. When the male fails to grasp the female, he chases her. Sometimes he is interrupted

TABLE 1.—*The average monthly diameter frequencies of ova of Gulaphallus during the spawning period. (Ova were taken from ten fishes at intervals of fourteen days.)*

Egg diameter	Diameter frequency.											
	1930		1931									
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.
mm.												
0.025–0.07	19	24	23	23	30	30	34	33	38	23	16	26
.071– .08	73	62	61	69	62	72	85	73	62	79	65	67
.081– .09	29	28	25	24	14	11	8	12	14	10	9	28
.091– .10	13	18	20	21	19	18	12	26	22	28	35	26
.101– .11	11	19	18	14	12	9	8	11	12	26	23	23
.111– .12	15	14	20	14	15	19	15	19	12	14	19	24
.121– .13	14	12	15	13	12	12	9	17	15	6	15	22
.131– .14	9	10	13	16	16	6	13	14	8	5	9	10
.141– .15	13	12	11	12	14	12	11	9	11	9	6	8
.151– .16	9	8	9	7	14	9	7	0	7	5	2	3
.161– .17	8	9	7	8	6	8	7	2	5	4	3	4
.171– .18	7	8	6	10	7	10	3	0	7	4	8	3
.181– .19	12	7	7	9	10	7	9	9	8	8	9	0
.191– .24	9	10	4	9	8	9	5	11	9	7	10	3
.241– .29	6	8	10	8	9	7	11	4	8	6	8	2
.291– .34	10	10	8	6	10	12	8	10	8	5	4	4
.341– .39	10	8	9	7	9	11	7	8	8	8	8	2
.391– .44	9	5	8	5	7	8	3	13	11	10	11	8
.441– .49	6	8	6	5	6	8	7	1	9	14	8	6
.491– .54	4	6	4	3	4	3	5	2	5	6	6	7
.541– .59	5	3	2	3	4	2	3	1	4	6	7	5
.591– .64	3	2	3	2	1	2	5	0	2	3	4	4
.641– .69	1	1	1	2	1	3	4	3	3	2	3	3
.691– .74	1	0	0	2	0	2	3	5	2	3	2	2
.741– .79	0	0	1	0	2	4	3	5	1	3	4	1
.791– .84	0	1	1	0	2	2	1	4	0	1	0	3
.841– .89	2	3	2	1	0	0	0	0	1	0	0	0
.891– .94	0	1	1	3	1	0	1	4	1	2	2	0
.941– .99	2	1	2	2	2	2	3	2	2	1	1	4
.991–1.04	2	3	3	2	3	2	5	2	5	2	3	2
Total	300	300	300	300	300	300	300	300	300	300	300	300

by a rival. It was observed that the victorious male drives away the vanquished. Some females were observed to approach males or swim around them at the time trying to flash their silvery white bellies. This behavior of the female probably attracts the males during the breeding season when the female is laden with ripe eggs. Newman (1906–1907) observed a similar behavior in *Fundulus majalis* Linnæus, where the females laden with ripe eggs frequently displayed themselves by

turning on the sides of the males near the bottom, spurning them with their tails, and causing their silvery white bellies to flash in the light.

During copulation the female *Gulaphallus mirabilis* lies on the aproctal side (either left or right) of her mate, depending upon the position of the toxactinium of the male. The toxactinium which curves toward the aproctal side grips the female under the chin and across the back part of the head, while the ctenactinium takes a firm hold on the pectoral region in front and on the side of the genital orifice until the penislike structure is introduced into the orifice.

While in this position, the pair swims about the aquarium. It may be assumed that during this time the sperm is discharged into the oviduct. The discharge of the sperm into the oviduct and its storage there are shown by the presence of active sperm in this region of a female that has just undergone copulation. Thus copulation in *Gulaphallus mirabilis* is apparently intromittent. The eggs are probably fertilized as they pass out through the oviduct, as may be judged from the fact that freshly extruded eggs when cultured in water free from sperm have been found to develop and hatch.

Copulation was observed in the aquarium to last for from one to two minutes. Copulating pairs have been observed to seperate at once when disturbed by the other fishes. Sometimes the female struggled as if trying to separate from her mate.

SPAWNING SEASON

(*a*) *Condition of the ovary during the spawning season.*—A spawning female has three classes of eggs in the ovary. These are:

1. The immature eggs (group I) (Plate 2, fig. 1) measure from 25 μ to 129 μ in diameter. This group is represented by the largest number of eggs, the mode of which was found to be 0.07 millimeter for the three groups of eggs. This group is very transparent and appears slightly creamy when preserved in 10 per cent formalin solution, and is not visible to the naked eye. This kind of eggs is present in sexually mature females at all times throughout the year.

2. The intermediate eggs (group II) (Plate 2, fig. 2) measure from 130 μ to 410 μ in diameter. The eggs are creamy white and opaque with threadlike processes wound tightly around them in a labyrinthine manner. The presence of this class of eggs

in a female may be regarded as an indication of approaching maturity.

The immature and intermediate classes of eggs were readily separated from the maturing ova (group III) as the immature and intermediate classes were still bound together by the connective tissue of the ovary, while the maturing eggs (group III) were either free or loosely attached by the same tissue.

3. The maturing eggs (group III) (Plate 2, fig. 3) measure from 0.411 to 1.03 millimeters in diameter. The eggs are orange, translucent rather than opaque, and the threadlike processes have loosened up. When the size limit of about 1 millimeter is reached, the egg is expelled and deposited.

The ovary of the spawning female during the spawning season is very much distended, occupying almost one-fourth of the abdominal cavity (Plate 3, fig. 3). During the spawning period, however, some adult females were found with only immature and intermediate groups of eggs. This indicates that either the fish had not yet developed the maturing eggs or the maturing group of eggs has just been spawned.

(*b*) *Time of spawning.*—The spawning season was determined by collection and measurement of ova at intervals of fourteen days from November, 1930, to October, 1931. It was found that the fish spawns throughout the year, as spawning individuals could be found at all times during the year (fig. 1). During the course of this study mature eggs could be secured at any time for embryological study.

Fig. 1 is a summary of diameter frequencies of ova measured at intervals of fourteen days. Each curve represents the average of two measurements a month of 300 ova taken from ten fishes selected at random at each inspection.

The frequency curves in fig. 1 further lead to the following interpretations: (*a*) The rate at which the intermediate class of ova are derived from the immature group by the process of development and growth is slow and gradual. (*b*) This is also true within the transformation of the intermediate class into the maturing class of ova. This assumption is reënforced by the fact that spawning females have been repeatedly observed to contain only a few maturing ova at a time, the number varying from five to thirty, depending upon the size of the female. The sudden drop in fig. 1 of the frequency curves from the mode confirms the foregoing conclusions. With the exception of a few small, and probably insignificant, fluctuations, the remainder of

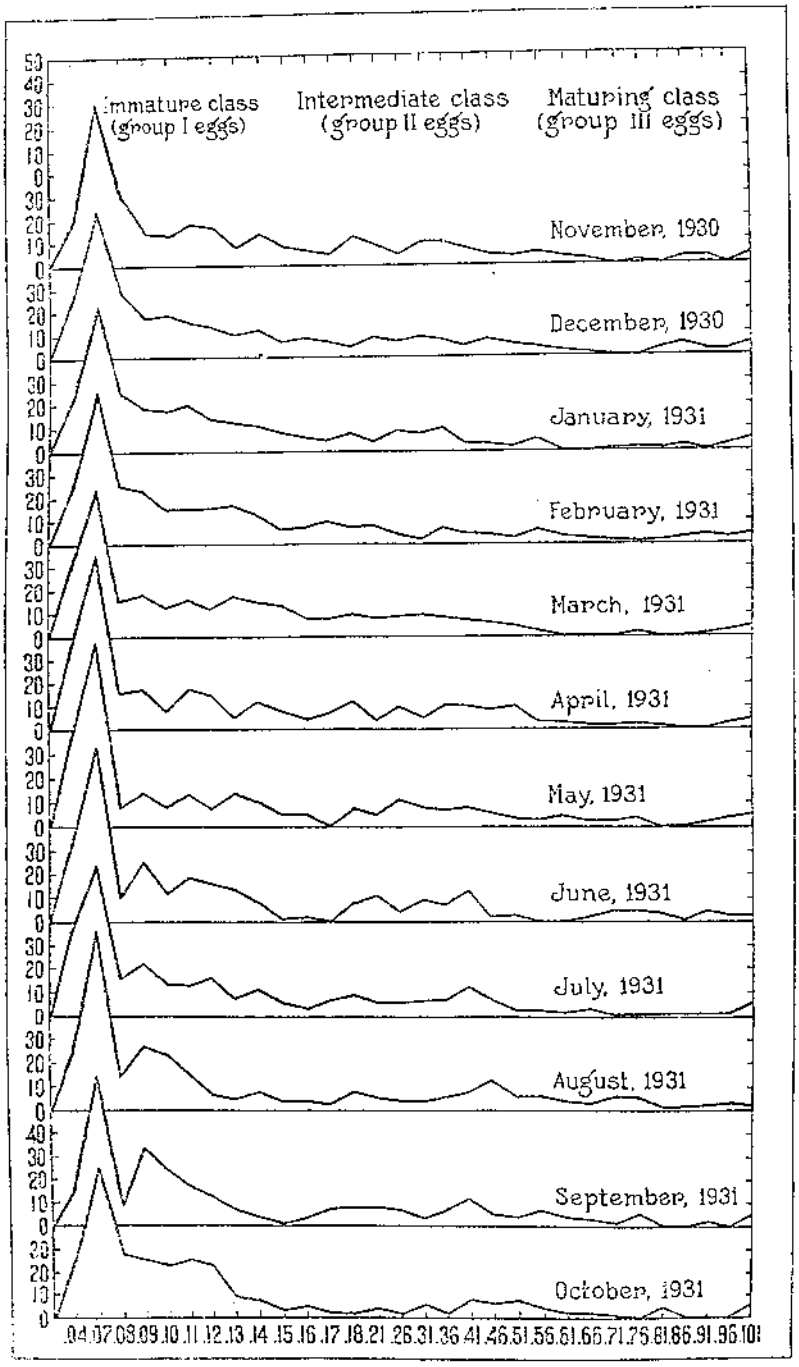

FIG. 1. Diameter frequencies of ova during the spawning season, Molawin Creek, November, 1930, to October, 1931. (Based on Table 1.)

the curve from the base of the mode, beginning with 0.09 millimeter and ending at 1.01 millimeters, represents a markedly gradual slope. Eggs about 1 millimeter in diameter are ready to be expelled.

(*c*) *Peak of spawning activity.*—Examination of mature females was made at intervals of fourteen days throughout the year. The percentage of spawning fish for each examination was computed. Table 5 shows that the greatest number of spawning fish was found in the samples collected during December, with a percentage of 58.67, and January, with 80.45 per cent. Greater spawning activity during January may be further indicated by the presence of larvæ of *Gulaphallus* in the stomachs of its own kind during that month. One year's examination of the stomach contents of both the immature and mature *Gulaphallus* shows that only during the month of January larvæ of this fish represented food of the same fish.

As may be expected, the least number of spawning *Gulaphallus* was found during May and June (Table 5). These conclusions, however, must be considered as tentative in view of the fact that sampling was done only twice a month. Our results to date, nevertheless, seem to show that the spawning season of *G. mirabilis* continues throughout the entire year.

FOOD AND FEEDING HABITS OF GULAPHALLUS

Thirty mature and thirty immature fish were collected, dissected, and examined every month. Tables 2 and 3 and figs. 2 and 3 show the results of the examination of the food of the fish. It may be seen that both the immature and the mature fish subsist upon practically similar kinds of food, the difference being merely in quantity.

(*a*) *Vegetable matter.*—Vegetable matter was found in the stomachs of both to the amount of 8.69 ± 0.978 per cent of the total bulk of food consumed by the mature and 13.01 ± 0.782 per cent by the immature. The difference of 4.319 ± 1.121 between the amount of vegetable matter consumed by the mature and by the immature fish is significant in indicating that as the fish become older they subsist very largely on animal matter. This food was found to be taken by both throughout the year, that is, from September, 1930, to August, 1931.

(*b*) *Chironomid larvæ and pupæ.*—These items rank first in importance among the food of the fish. They form 33.39 ±

2.38 per cent for the immature and 38.35 ± 2.02 per cent for the mature fish of the total bulk of food consumed. This animal food, like the vegetable matter, is taken by the fish as part of its diet throughout the year. The difference of 4.96 ± 3.12

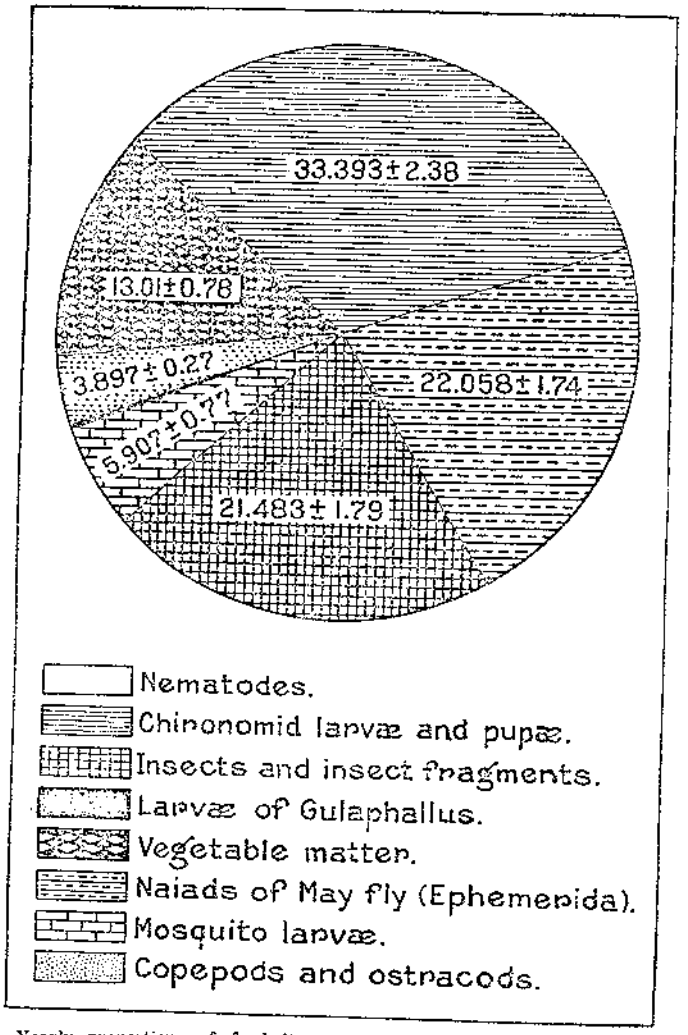

FIG. 2. Yearly proportions of food items consumed by the immature *Gulaphallus*.

per cent in the amount of these items consumed by the immature and mature groups is not significant.

(*c*) *Insects and insect fragments.*—Among the insects that were found occasionally in the stomachs of the mature fish were water beetles and adult mosquitoes. On the other hand, water

beetles, termites, and ants were found in the stomachs of the immature group. In each group, insects and insect fragments were represented in the diet throughout the year.

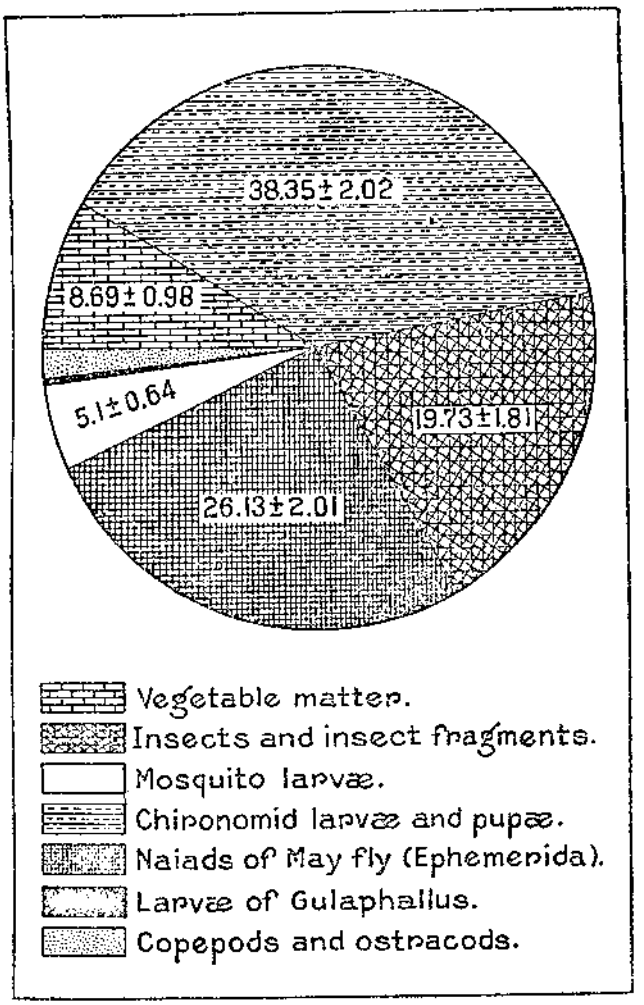

FIG. 3. Yearly proportions of food items consumed by the mature *Gulaphallus*.

Of the total bulk of food taken, the mature group consumed 19.73 ± 1.81 per cent and the immature, 21.48 ± 1.79 per cent. The difference of 1.75 ± 2.1 per cent, however, in the amount consumed by the two groups of fish was found to be of no significance.

TABLE 2.—*The monthly range of food of immature Gulaphallus.*

Food.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Vegetable matter	7.21	9.00	18.45	10.66	19.50	15.50	15.53	17.13	12.27	8.43	10.42	12.00	13.003±0.782
Chironomid larvæ and pupæ	56.07	35.00	48.85	23.38	23.75	25.86	16.92	29.15	20.36	36.37	44.64	40.36	33.393±2.381
Insects and insect fragments	5.98	15.12	20.17	36.00	34.09	30.33	20.13	18.77	25.91	26.08	10.89	14.33	21.483±1.794
Naiads of May flies (Ephemerida).	20.84	27.80	4.03	21.30	13.61	20.05	34.50	20.26	36.37	14.71	26.92	24.31	22.058±1.740
Mosquito larvæ	6.22	10.80	5.47	4.50	3.30	2.21	8.27	8.46	2.89	9.34	3.42	6.00	5.907±0.172
Larvæ of *Gulaphallus*					2.05								0.171±0.113
Copepods and ostracods	3.68	2.28	2.03	4.16	3.70	6.05	4.65	6.23	2.20	5.07	3.71	3.00	3.897±0.270
Nematodes			1.00										0.088±0.053
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

TABLE 3.—*The monthly range of food of mature Gulaphallus.*

Food.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Vegetable matter	3.00	5.41	16.25	12.66	18.50	5.83	9.07	8.33	10.43	3.53	3.05	8.21	8.689±0.978
Chironomid larvæ and pupæ	32.66	38.83	37.25	32.69	27.25	49.15	25.48	50.55	27.69	34.14	56.11	48.92	38.351±2.017
Insects and insect fragments	22.66	8.32	34.30	31.67	19.50	14.49	29.47	13.33	19.00	26.17	5.72	12.14	19.732±1.808
Naiads of May flies (Ephemerida).	27.68	42.94	2.00	19.67	29.00	23.53	25.75	19.46	40.23	28.23	28.44	26.65	26.132±2.010
Mosquito larvæ	12.98	3.94	9.36	2.41	1.47	5.79	5.06	5.13	1.59	4.09	6.02	3.36	5.100±0.641
Larvæ of *Gulaphallus*					3.50								0.292±0.619
Copepods and ostracods	1.02	1.06	0.94	0.90	0.78	1.21	5.17	3.20	1.06	3.84	0.66	0.72	1.705±0.285
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

TABLE 2.—*The monthly range of food of immature Gulaphallus.*

Food.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Vegetable matter	7.21	9.00	18.45	10.66	19.50	15.50	15.53	17.13	12.27	8.43	10.42	12.00	13.008±0.782
Chironomid larvæ and pupæ	56.07	35.00	48.35	23.38	23.75	25.86	16.92	29.15	20.36	36.37	44.64	40.36	33.893±2.381
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Nematodes			1.00										0.083±0.053
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

TABLE 3.—*The monthly range of food of mature Gulaphallus.*

Food.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
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Larvæ of *Gulaphallus*					3.50								0.292±0.619
Copepods and ostracods	1.02	1.06	0.94	0.90	0.78	1.21	5.17	3.20	1.06	3.84	0.66	0.72	1.705±0.285
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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Food.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Vegetable matter	7.21	9.00	18.45	10.66	19.50	15.50	15.53	17.13	12.27	8.48	10.42	12.00	13.008±0.782
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Nematodes			1.00										0.083±0.053
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
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Larvæ of *Gulaphallus*					3.50								0.292±0.619
Copepods and ostracods	1.02	1.06	0.94	0.90	0.78	1.21	5.17	3.20	1.06	3.84	0.66	0.72	1.705±0.285
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

(*d*) *Naiads of May flies* (*Ephemerida*).—The mature group consumed 26.13 ± 2.01 per cent and the immature 22.06 ± 1.74 per cent of the total bulk of food taken. Like the three foregoing items, naiads of May flies were represented in the stomachs of both groups of fish throughout the year. The difference of 4.074 ± 2.6 in the amount of these items consumed by the mature and immature groups is not significant.

(*e*) *Mosquito larvæ*.—These items were represented in the stomachs of both the mature and immature fish to the amount of 5.10 ± 0.641 per cent of the total bulk of food consumed for the mature and 5.91 ± 0.172 per cent for the immature. The difference of 0.81 ± 0.67 is not significant.

(*f*) *Larvæ of Gulaphallus*.—Outside the month of January, the larvæ of the fish were never represented in the monthly range of food of each group of fish. This food item formed 3.5 per cent of the total amount of food consumed for that month for the mature group and 2.05 per cent for the immature.

The larvæ of the fish as a part of its diet represent only 0.292 ± 0.62 per cent of the total bulk of food consumed for the mature and 0.171 ± 0.113 per cent for the immature. The difference of 0.121 ± 0.61 per cent in the total bulk of this item is not significant.

(*g*) *Copepods and ostracods*.—These crustaceans formed the least of the minor food of the fish. They formed only 3.90 ± 0.270 per cent of the total bulk of food consumed for the immature and 1.74 ± 0.285 for the mature. These items were also found in the stomachs of both groups of fish throughout the year. The difference of 2.192 ± 0.0391 per cent was found to be significant.

(*h*) *Nematodes*.—These formed only 0.083 ± 0.053 per cent of the total bulk of food consumed by the immature group. This item was found to be taken only in the month of November when it formed 1.00 per cent of the amount of food consumed for that month. It was not found in the stomachs of the mature fish. There is a possibility that these animals were parasitic in the alimentary tract of the young fish.

From the foregoing results of the feeding habits of *Gulaphallus* the following conclusions may be deduced:

1. It is apparent that both groups of fish are more insectivorous than herbivorous.

2. Chironomid larvæ and pupæ, naiads of May flies (Ephemerida), and insects and insect fragments, form the major

portions of the animal food of both the mature and immature groups.

3. Mosquito larvæ, vegetable food materials, and crustaceans (copepods and ostracods) form minor foods of both.

4. Larvæ of *Gulaphallus* were taken by both groups of fish only during January. This apparently shows that the fish became accidental cannibals only during this month, when the peak of spawning activity was found to occur.

5. The essential difference between the food of the immature and mature fish is only in the amount of vegetable materials and crustacean food (copepods and ostracods) eaten. It is evident that the immature group took more vegetable food materials and crustacean food than the mature group. The immature fish appears to become insectivorous as it grows older. No indication, however, could be found that the mature fish at any stage prefers a particular kind of insect food.

EMBRYOLOGY OF GULAPHALLUS MIRABILIS

(*a*) *The newly laid eggs* (*Plate 2, fig. 4*).—These are highly transparent, spherical, with a diameter of about 1 millimeter. They are demersal eggs held by a tangle of adhesive threadlike processes (Plate 2, fig. 4, *at*), which arise from the different parts of the egg membrane. These adhesive processes attach the egg to any object in the spawning ground. It seems, however, that plants are preferred to stones and decaying wood as sites for oviposition.

The yolk sphere contains 70 to 80 oil globules of unequal size. Numerous tiny globules are also scattered through the cytoplasmic mass. Newly laid eggs that are presumably fertilized remain highly transparent up to one hour or more after laying.

(*b*) *Incubation period.*—Under laboratory conditions the period of incubation during the months covered by the experiment lasts from eight to eleven days with an average of 9.50 ± 0.079 days (Table 4). The eggs were hatched in Petri dishes containing tap water which was changed daily up to the time of hatching.

(*c*) *Embryology* (*Plate 2, figs. 4 to 22*).—Observations on the embryonic development were made exclusively on living materials. Newly laid eggs placed in Petri dishes half filled with tap water were used in this study.

TABLE 4.—*The incubation period of eggs of Gulaphallus under laboratory conditions (submerged in water).*

Lot No.	Eggs laid.	Eggs hatched.	Incubation period.
	1930	1930	*Days.*
I	11-XI	22-XI	11
II	17-XI	27-XI	10
III	22-XI	30-XI	8
IV	28-XI	8-XII	10
V	6-XII	15-XII	9
	1931	1931	
VI	26-I	4-II	9
VII	31-I	11-II	11
VIII	6-II	15-II	9
IX	6-II	16-II	10
X	8-II	16-II	8
Maximum			11
Minimum			8
Average			9.50±0.079

(*d*) *Early cleavage to formation of blastodisc.*—The newly laid eggs have a relatively narrow perivitelline space. This space apparently becomes wider about one hour or more after laying. The blastodisc (Plate 2, fig. 5, *bd*) becomes well differentiated about one hour after laying, appearing as a lenticular protrusion of protoplasm at one pole of the yolk sphere. As differentiation of the blastodisc proceeds, the oil globules collect at one pole of the yolk sphere, usually opposite the blastodisc.

First cleavage occurs about two hours after laying. The blastodisc divides into two approximately equal daughter cells (Plate 2, fig. 6). About three hours after laying, the second plane of cleavage appears, cutting the first at right angles and dividing the blastodisc into four approximately equal daughter cells (Plate 2, fig. 7).

The blastodisc with eight cells possesses distinct bilateral symmetry (Plate 2, fig. 8). After this stage, however, cell division becomes irregular, the bilateral arrangement of the constituent cells disappears, and cells of variable size are produced. A blastodisc about six hours old (Plate 2, fig. 10) appears somewhat dome-shaped with the periblast and periblastic nuclei (Plate 2, fig. 10, *pb*) becoming apparent around its periphery. The per-

TABLE 5.—*The monthly percentage of mature egg-bearing Gulaphallus from samples collected at 14-day intervals from Molawin Creek.*

Date.	Fish examined.	Fish with mature eggs.		Average for the month.
			P. ct.	*P. ct.*
1930				
16–XI	50	16	32.00	33.31
29–XI	52	18	34.62	
13–XII	51	34	66.67	58.67
27–XII	66	28	50.00	
1931				
10–I	54	48	88.89	80.45
24–I	50	36	72.00	
7–II	55	20	36.36	40.73
21–II	51	23	45.10	
7–III	56	27	48.21	40.77
21–III	60	20	33.33	
4–IV	62	20	32.26	34.31
18–IV	66	24	36.36	
2–V	58	19	32.76	27.49
16–V	54	12	22.22	
30–V	40	8	20.00	
13–VI	45	13	28.88	29.31
27–VI	51	20	39.22	
11–VII	55	30	54.54	43.94
25–VII	48	16	33.33	
8–VIII	45	14	31.11	31.11
22–VIII				
5–IX	50	14	28.00	32.75
19–IX	56	21	37.50	
3–X	40	18	45.00	
17–X	56	28	50.00	47.29
31–X	64	30	46.88	

iblastic nuclei are doubtless derived from the peripheral cells of the blastoderm and the periblast is believed to have something to do with the assimilation of the yolk by the developing embryo.

The blastoderm continues to increase in diameter and ultimately spreads over the entire surface of the yolk. In embryos nine hours old, the blastoderm covers about one-half of the surface of the yolk (Plate 2, fig. 11).

(*e*) *Formation of the primitive streak and early embryonic stages.*—The cell layers at the edge of the blastoderm thicken about twenty hours after hatching. This thickened region is the germ ring (Plate 2, fig. 12, *gr*). The subgerminal cavity (Plate 2, fig. 12, *sg*) becomes evident also at this time by the thinning of the central area of the blastoderm.

Before the germ ring is fully differentiated, however, a thickening becomes apparent at the posterior or embryonic pole of the blastoderm (Plate 2, fig. 12, *es*). This is the embryonic shield, a broad tongue of cells which grows forward (Plate 2, fig. 12, *es*). The embryonic shield grows larger and becomes more definitely outlined. About eight hours after the formation of the germ ring there occurs a linear thickening along its anteroposterior axis. This linear thickening is the primitive streak (Plate 2, fig. 13, *ps*), with the prospective head of the animal at its tip.

On the lateral sides of this, the lens and optic vesicles become apparent about thirty-six hours after oviposition. At this time also, five to seven somites are in evidence (Plate 2, fig. 14, *sm*). The oil globules are now grouped together at about the caudal end of the embryo. About twelve hours later, the eyes become prominent and from 14 to 16 somites are fully developed, (Plate 2, fig. 15). The oil globules are now diffusely scattered in the yolk mass. The metameric segments increase in number with the age of the embryo.

(*f*) *Later embryonic stages.*—Sixty-two hours after laying pigmentation begins to develop. The black pigments first appear as rounded dots scattered over the dorsal and lateral aspects of the head. Early embryonic circulation also becomes manifest at this time. The heart (Plate 2, fig. 16, *h*) is very distinct. The membranous fold which extends from the middorsal region around the caudal end and along the ventral side of the embryo, is already differentiated (Plate 2, fig. 16, *mf*). The embryo now covers about two-thirds of the surface of the yolk sphere.

About twenty-six hours later, the punctiform black pigments develop into pigmented processes which are scattered from the dorso-medial aspect of the head up to the anterior portion of the trunk region (Plate 2, fig. 17).

The formative pectoral fins are observed in embryos about one hundred two hours after laying. They appear as more or less triangular protrusions arising laterally at about the neck region (Plate 2, fig. 18, *pa*). The black chromatophores increase in number and size on the dorsal aspect of the head, pectoral region, and extra-embryonic area.

The embryo has grown considerably in length and has completely extended around the circumference of the yolk sphere by about one hundred twenty-six hours after laying. The for-

mative pectoral fins are also considerably elongated. The black chromatophores have increased further in number on the dorsal aspect of the head, the anterior region of the trunk, and along the lateral and dorsal sides of the body (Plate 2, fig. 19). About thirty-four hours later, the formative pectoral fins become differentiated into pectoral fins (Plate 2, fig. 20). The black chromatophores become aggregated on the top of the head.

About three hours before hatching, the embryo has grown considerably in size (Plate 2, fig. 21). The head is very much enlarged and occupies almost one-third of the egg. The yolk is materially reduced, and the larva is observed wiggling furiously at about this time.

The larva is liberated about two hundred and eleven hours after laying. It is very active soon after its escape from the egg membrane. The black chromatophores are now arranged in series along the dorsal aspect of the head.

The exact cause of the rupture of the egg membrane could not be determined. It was assumed, however, that the rupture was due to the wiggling action of the larva.

POSTEMBRYONIC DEVELOPMENT, WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF THE MALE COPULATORY ORGANS

In the study of the development and position of the male copulatory organs of *Gulaphallus*, newly hatched fish reared in glass aquaria were used. The work was carried on for three and one-half months, from June 15 to October 31, 1931. Observations were made at intervals of seven days on twenty newly hatched larvæ.

(*a*) *The newly hatched larva* (*Plate 2, fig. 22*).—Newly hatched larvæ measure about 4 millimeters in length. The head is somewhat enlarged and flattened ventrally and convex dorsally; the eyes are large and slightly elliptical; the body is transparent, slender, and slightly tapering posteriorly. Black chromatophores are visible from the dorsal aspect of the head and along the dorsal and lateral sides of the body up to the caudal region.

The yolk sac which appears as an orange semiovoid structure is located on the ventral side, a little posterior to the head region. Resorption of the yolk is complete about two or three days after hatching. The pectoral fins, aided by the vibratory movement of the caudal region, are used as the primary propellers of the body for swimming.

The mid-dorsal region gives rise to a low median fold which continues to form around the caudal end and subsequently extends its formation along the ventral side, ending at the posterior border of the yolk sac.

(*b*) *Early manifestation and development of the fins.*—About the first and the second week after hatching, the ventral, mid-dorsal, and anal folds begin to disintegrate. Yellowish orange chromatophores appear among the original black chromatophores on the dorsal aspect of the head and along the lateral sides of the body.

Delicate fin rays become manifest on the caudal, mid-dorsal, and ventral folds about three to four weeks after the animal hatches (Plate 3, fig. 1). It is apparent that the second dorsal, anal, and caudal fins in *Gulaphallus mirabilis* develop synchronously. About five weeks after hatching, the second dorsal, anal, and caudal undergo rapid development, while the first dorsal fin is not yet in evidence (Plate 3, fig. 2).

(*c*) *Early differentiation and development of the male copulatory organs.*—In twelve of the twenty larvæ indications of the formative copulatory organs of the male are first seen at about the sixth or the seventh week after hatching. They appear as bilobed, posteriorly directed outgrowths originating from the ventral side of the throat region and extending to about the base of the pectoral fins (Plate 3, figs. 5 and 5*a*, *cpa*). The anal opening, *a*, is discernible between the bases of these two outgrowths. At about this time, the first dorsal fin also makes its appearance a few millimeters anterior to the second dorsal fin. The first dorsal fin at this stage possesses two spinous rays, which is characteristic of the genus.

During the eighth and the ninth week, the formative copulatory structures increase in size. By about the tenth week, one of the lobes outgrows the other and the two coalesce along the ental side (Plate 3, figs. 6 and 6*a*). About the twelfth and the thirteenth week (Plate 4, figs. 1 and 1*a*) the fused lobes develop into a more or less elongate subfusiform structure. At this stage this structure is intimately apposed along almost its entire length from the base subdistally to the throat of the fish. This stage marks the beginning of the development of the priapium.

(*d*) *Early development of the priapium and manifestation of the priapial accessory appendages.*—Fourteen weeks after the fish hatches, the priapium elongates. The anterior end of the priapium is in line with the centers of the eyes and the posterior

end extended to about half beyond the pectoral fins (Plate 4, figs. 2 and 2*a*). The anus now begins to assume a lateral left or right position, on account of the twisting of the priapium. A cartilaginous protuberance, which is apparently the formative toxactinium, arises on the aproctal side lateral to the posterior part of the priapium (Plate 4, fig. 2*a*, *tf*). This formative structure cannot possibly be the formative penislike structure, because as seen in the subsequent stages, the latter is posteromesal in position.

About the fifteenth or the sixteenth week after the animal hatches, the formative penislike structure and the formative ctenactinium are already in evidence (Plate 4, figs. 3 and 3*a*). The formative penislike structure appears as a fleshy protuberance at the posterior end of the priapium. Because of the twisted condition of the priapium this structure seems to be inclined towards one side, adjoining the developing toxactinium. The formative ctenactinium appears as a slender cartilaginous thickening along the ventral side of the priapium. The priapium at this time increases considerably in length towards the anterior end to about the base of the lower jaw.

It appears that the priapial appendages are homologous lateral structures, one becoming the toxactinium and the other the ctenactinium, depending upon which side the priapium twists to. The toxactinium then is the one that ultimately retains a lateral position and the ctenactinium, the ventral. These two structures fuse together at their bases during the early stages of development, and probably develop from a common base.

(*e*) *Later development of the priapium and its accessory appendages.*—About seventeen weeks after the animal hatches, the distal part of the short ctenactinium (Plate 4, figs. 4 and 4*a*) is free. The toxactinium increases considerably in length until the tip is about in line with the centers of the eyes. The toxactinium and the ctenactinium at this stage of development are cartilaginous. At about the eighteenth week, four of the ten males in the culture have fully developed priapia and upon dissection are found to be sexually mature. At this stage also, the ctenactinium is completely free from the priapial muscle in its entire extent. The priapium when fully developed extends from the base of the lower jaw to the anterior limit of the throat. The posterior or basal end of the priapium is very much enlarged due to the complete development of the seminal vesicle (Plate 4, figs. 4 and 4*a*, *sv*).

The fully developed ctenactinium (Plate 4, figs. 5 and 5*a*) is broad and shorter than the toxactinium, and has an expanded tip, which is concave and emarginate distally. At this stage the toxactinium has increased further in length up to about the base of the lower jaw. The penislike structure, likewise, has apparently attained its maximum development; it is pointed anterolaterally, with the opening of the vas deferens at its somewhat forked tip. Its distal end is placed between the proximal portions of the toxactinium and the ctenactinium. It develops also an axial bone at this stage of development. In the remaining six males the priapia and accessory appendages become fully developed about nineteen to twenty weeks after hatching. The full development of the priapium is an index of sexual maturity. Regan (1916) arrived at an identical conclusion in connection with this study on *Myxopterygia* and *Neostethus bicornis*, close relatives of *Gulaphallus*.

The fully developed toxactinium and ctenactinium (Plate 5, figs. 1 and 1*a*) is pliable, but bony instead of being cartilaginous. A part of the subdistal curve of the long ctenactinium rests in a groove formed by the lower jaw and the anterior portion of the priapium.

SUMMARY

1. Four members of the family Phallostethidæ are known in the Philippines, all from Luzon. These are *Mirophallus bikolanus* Herre, *Gulaphallus eximius* Herre, *Gulaphallus mirabilis* Herre, and *Gulaphallus amaricola* sp. nov.

2. A rather comprehensive treatise of the biology of *Gulaphallus mirabilis* Herre is presented in the present report.

3. Copulation in *G. mirabilis* is intromittent, the duration being one to two minutes.

4. In the aquarium the eggs of *Gulaphallus* are laid singly and attached to leaves and stems of *Ceratophyllum* by adhesive threadlike processes. The eggs receive no parental care after oviposition.

5. The fish spawns throughout the year, but spawning is at its height in December and January and rarest in May and June.

6. Three classes of ova are recognized as occurring simultaneously in the ovary of a spawning female; namely, the immature class (group I eggs), the intermediate class (group II eggs), and the maturing class (group III eggs).

7. The transformation of the immature group into the intermediate class of ova is gradual. The same is also true in the transformation of the intermediate class into the maturing class of ova.

8. The following salient points were observed in the embryology of *G. mirabilis*.

(*a*) The blastodisc became differentiated about one hour after laying, and the first act of cleavage occurs about one hour later. Cleavage is bilateral and regular up to the 8-cell stage, becoming irregular from the 16-cell stage.

(*b*) The periblast and periblastic nuclei become apparent about six hours after laying.

(*c*) The germ ring becomes evident about twenty hours after laying. The subgerminal cavity and the embryonic shield are also apparent by this time.

(*d*) The primitive streak appears about eight hours after oviposition.

(*e*) The embryonic circulation and pigmentation becomes apparent in embryos about sixty-two hours after laying.

(*f*) The primordial pectoral fins appear in embryos about one hundred two hours after laying, and by about fifty-eight hours later they differentiate into definitive pectoral fins.

9. The period of incubation of the eggs during the months covered by the experiment under laboratory conditions varies from eight to eleven days with an average of 9.50 ± 0.079 days.

10. The following is a summary of the post-embryonic development of the fish.

(*a*) The second dorsal, anal, and caudal fins appear synchronously about the third and fourth week after hatching.

(*b*) The primordial copulatory organs of the male first appear at about the sixth or the seventh week after hatching. At about this time the first dorsal fin makes its appearance.

(*c*) The early development of the priapium begins at about the twelfth and thirteenth week after hatching.

(*d*) The anlage of the toxactinium becomes evident about fourteen weeks after hatching.

(*e*) The anlagen of the penislike structure and of the ctenactinium make their appearance at about the fifteenth or the sixteenth week after hatching.

(*f*) The priapial appendages appear to be externally homologous lateral structures, one becoming the toxactinium and the other the ctenactinium, depending on whether the priapium takes a dextral or a sinistral turn.

(*g*) The toxactinium and the ctenactinium remain cartilaginous during the early stages of development. They become bony but pliable structures when fully developed at about the nineteenth or twentieth week.

(*h*) The priapium reaches its maximum development at sexual maturity, about the eighteenth week.

(*i*) The penislike structure attains its maximum development about eighteen weeks after hatching.

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ILLUSTRATIONS

PLATE 1

pv, pulvinulus; *ct*, ctenactinium; *p*, penislike structure; *co*, comblike projections; *a*, anus; *o*, opening of oviduct; *pl*, papilla.

FIG. 1. *Gulaphallus amaricola* sp. nov., male; 1*a*, ventral aspect of head region of male. (Drawn by E. Borbe.)

2. *Gulaphallus amaricola* sp. nov., female; 2*a*, ventral aspect of head region of female. (Drawn by E. Borbe.)

PLATE 2. EGGS OF GULAPHALLUS MIRABILIS HERRE

FIG. 1. Immature egg, × 80.

2. Intermediate egg, × 100.
3. Maturing egg, × 52.
4. Newly laid egg (× 40) attached to a twig of *Ceratophyllum demersum* Linn. by adhesive threads, *at*.
5. One hour after oviposition; *bd*, blastodisc.
6. Two hours after oviposition.
7. Three hours after oviposition.
8. Four hours after oviposition.
9. Five hours after oviposition.
10. Six hours after oviposition; *pb*, periblast.
11. Nine hours after oviposition.
12. Twenty hours after oviposition; *gr*, germ ring; *sg*, subgerminal cavity; *es*, embryonic shield; *pp*, embryonic pole.
13. Twenty-eight hours after oviposition; *ps*, primitive streaks.
14. Thirty-six hours after oviposition; *sm*, somite.
15. Forty-eight hours after oviposition; 14 to 16 somites.
16. Sixty-two hours after oviposition; *h*, heart.
17. Eighty-eight hours after oviposition.
18. One hundred two hours after oviposition; *pa*, pectoral anlagen.
19. One hundred twenty-six hours after oviposition.
20. One hundred sixty hours after oviposition.
21. Two hundred hours after oviposition.
22. Newly hatched larva, × 40; *ys*, yolk sac.

PLATE 3. GULAPHALLUS MIRABILIS HERRE

FIG. 1. Three weeks after hatching, × 25. (Drawn by P. R. Manacop.)

2. Five weeks after hatching, × 25. (Drawn by P. R. Manacop.)
3. *Gulaphallus mirabilis* Herre, female, internal organs in situ, × 10. (Drawn by P. R. Manacop.)
4. *Gulaphallus mirabilis* Herre, male, internal organs in situ, × 8. (Drawn by P. R. Manacop.)

t, Testis; *ov*, ovary; *sv*, seminal vesicle; *p*, penislike structure; *a*, anus; *i*, coiled intestine; *s*, stomach; *ab*, air bladder; *u*, ureter; *o*, oviduct opening.

FIG. 5. Six to seven weeks after hatching, × 10; *a*, anus; *cpa*, formative copulatory organ; 5*a*, ventral aspect of same. (Drawn by P. Medel.)

6. Ten weeks after hatching, × 10; 6*a*, ventral aspect of same. (Drawn by P. Medel.)

PLATE 4. (DRAWN BY P. MEDEL)

FIG. 1. Twelve to thirteen weeks after hatching, × 10; *a*, anus; 1*a*, ventral aspect of same.

2. Fourteen weeks after hatching, × 10; *tf*, formative toxactinium; *a*, anus; 2*a*, ventral aspect of same.

3. Fifteen to sixteen weeks after hatching, × 10; 3*a*, ventral aspect of same; *ps*, formative penislike structure; *t*, toxactinium; *c*, formative ctenactinium.

4. Seventeen weeks after hatching, × 10; 4*a*, ventral aspect of same; *sv*, seminal vesicle.

5. Eighteen weeks after hatching; 5*a*, ventral aspect of same.

PLATE 5. (DRAWN BY P. MEDEL)

FIG. 1. Nineteen to twenty weeks after hatching, × 10; 1*a*, ventral aspect of same to show fully developed priapial appendages; *c*, ctenactinium; *t*, toxactinium; *ps*, penislike structure.

2. *Gulaphallus mirabilis* Herre, in copulation, × 6.

TEXT FIGURES

FIG. 1. Diameter frequencies of ova during the spawning season, Molawin Creek, November, 1930, to October, 1931. (Based on Table 1.)

2. Yearly proportions of food items consumed by the immature *Gulaphallus*.

3. Yearly proportions of food items consumed by the mature *Gulaphallus*.

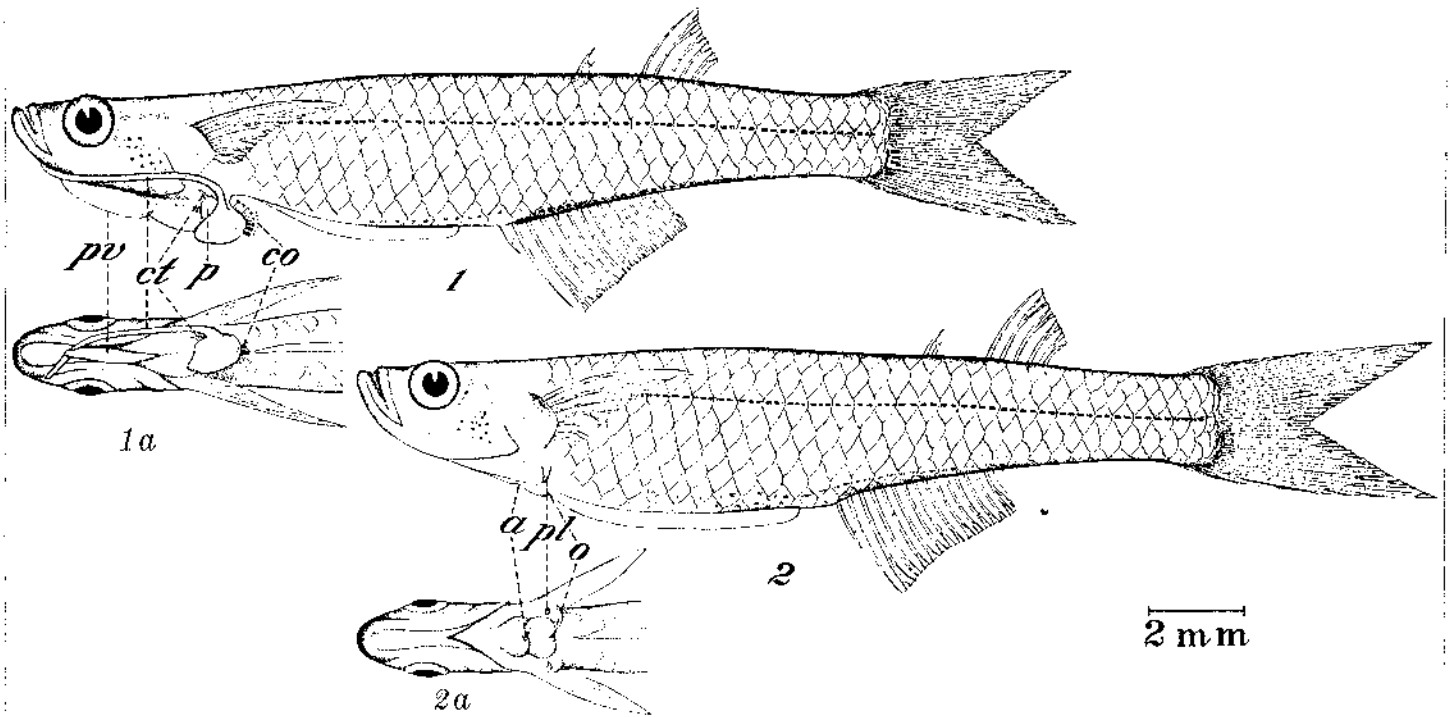

PLATE 1.

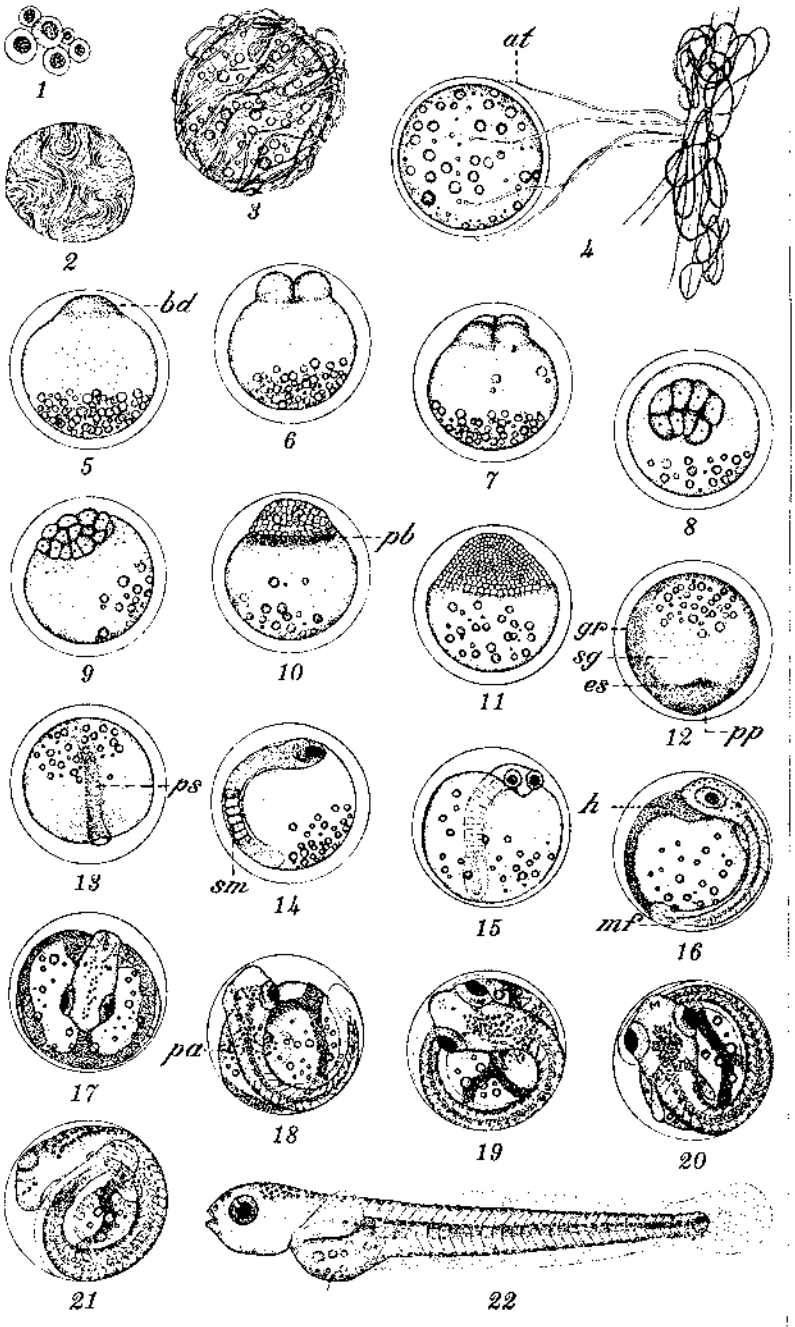
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PLATE 2.

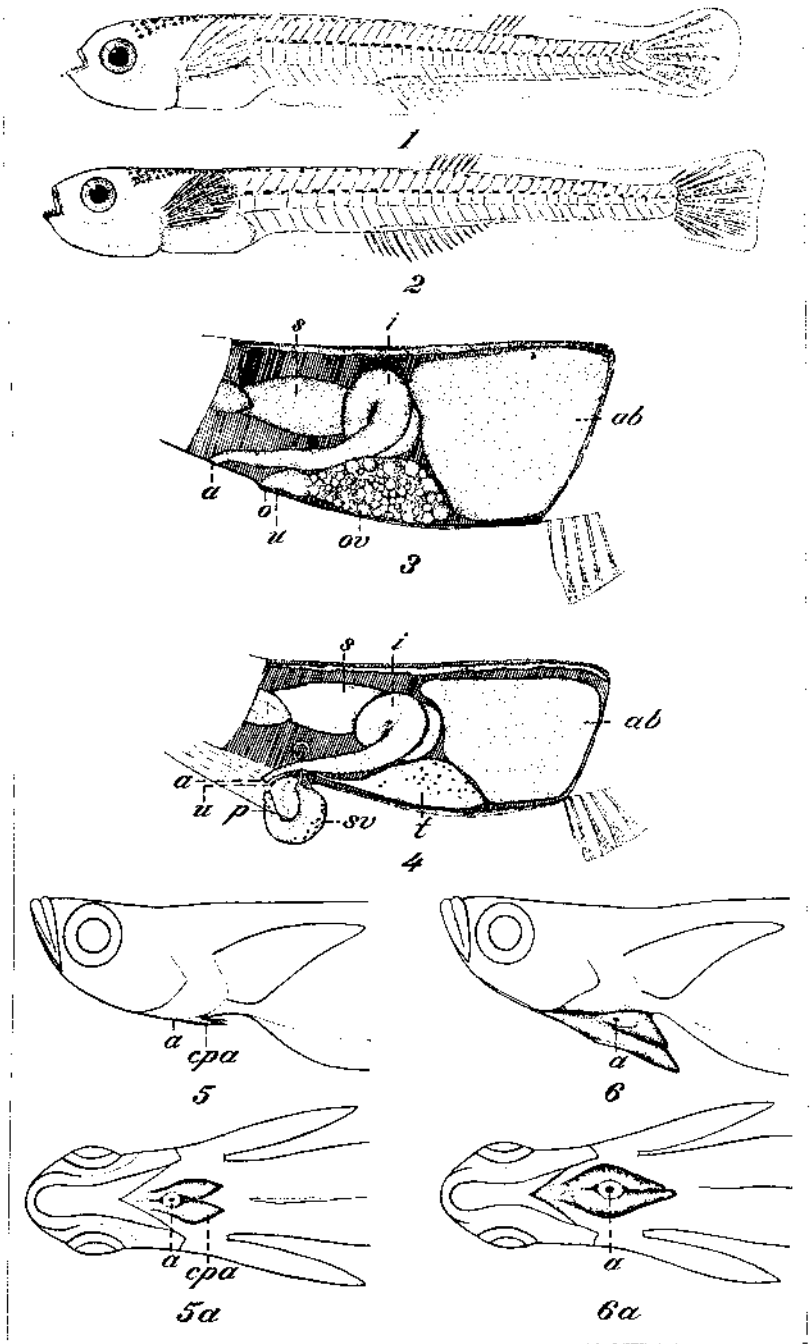

PLATE 3.

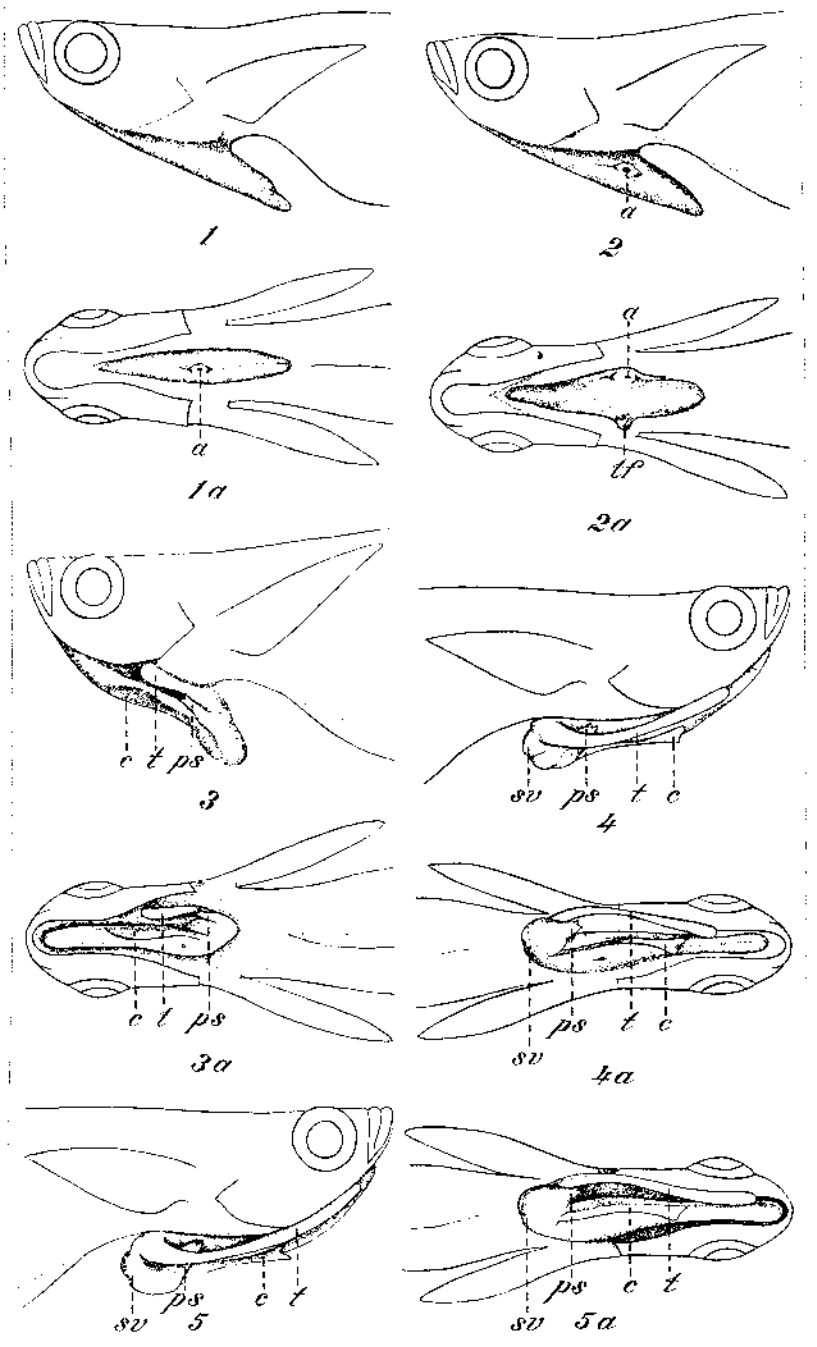
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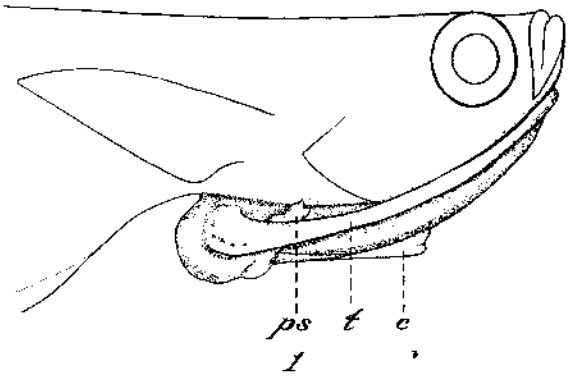
PLATE 4.



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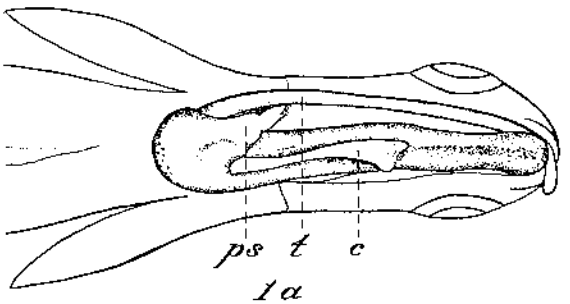

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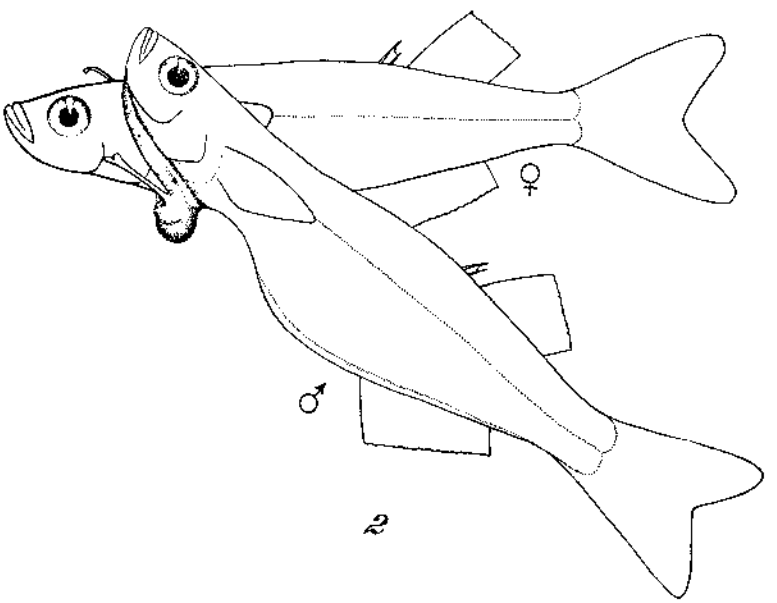

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PLATE 5.

PHILIPPINE SILLAGINIDÆ

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ONE PLATE

In the present paper is given a review of Philippine fishes belonging to the family Sillaginidæ, based on material in the collection of the Fish and Game Administration. Three species are herein described, one of which is believed to be new to science.

SILLAGINIDÆ

Body elongate, little compressed, tapering both ways from the spinous dorsal; head conical, with its muciferous system fully developed as in the Sciænidæ; eyes lateral, nearly median; preorbital very large, concealing the ends of maxillaries; mouth small, terminal, and slightly oblique, the upper jaw slightly the longer; villiform teeth in the jaws with the outer row rather conical, enlarged, and curved inward; teeth on vomer, none on palatines; preopercle serrated or crenulated; opercle armed behind with a short, flat spine; scales small, ctenoid, and cycloid; lateral line simple, slightly curved in front, and continued to base of caudal or a little beyond; two separate dorsal fins, the first short and consisting wholly of spines, the second very long, with one spine and over 17 rays; anal similar to second dorsal, with 2 spines; caudal emarginate; pectorals normal; ventral I, 5; branchiostegals 6; pseudobranchiæ present; air bladder simple; pyloric cæca few.

Fishes of this family are found from the Red Sea through the East Indies to Samoa, ranging northward to China, Korea, and Japan, and southward through the Philippines to the southeast of Australia. They are closely related to the Sciænidæ and are known to ascend rivers and estuaries. Their flesh is esteemed as light and wholesome food.

Genus SILLAGO Cuvier

Sillago CUVIER, Regne Animal, 1st ed. 2 (1817) 258.

This genus includes most of the species of the family, including all those with villiform teeth, in which the soft dorsal and anal are similar to each other, scales small, and the ventral spine normal.

Key to the Philippine species of Sillago.

a^1. Dorsal fins XI–I, 20 to 22; anal II, 21 to 23; silvery longitudinal band on side of body indistinct or absent; scales on cheek in two rows, cycloid ..... *S. sihama* (Forskål).

a^2. Dorsal fins XI–I, 17 to 19; anal II, 17 or 18; silvery longitudinal band on each side of body well pronounced; scales on cheek in three or four rows, cycloid or ctenoid.

b^1. With irregular blackish blotches on sides; longitudinal band narrow; scales on cheek ctenoid, in four rows.
S. maculata Quoy and Gaimard.

b^2. Without irregular blackish blotches on sides; longitudinal band wide; scales on cheek in three rows, those in upper row cycloid and in lower two rows ctenoid..... *S. argentifasciata* sp. nov.

SILLAGO SIHAMA (Forskål). Plate 1, fig. 1.

Atherina sihama FORSKÅL, Descr. Anim. (1775) 70.

Platycephalus sihamus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 60.

Sciaena malabarica BLOCH and SCHNEIDER, Syst. Ichth. (1801) 81; CANTOR, Cat. Malay. Fish. (1850) 1003.

Sillago acuta CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 296; BLEEKER, Percoidea, Verh. Batav. Gen. 22 (1849) 61; Kner, Reise, Novara (1865–1887) 128.

Sillago erythræa CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 301.

Sillago sihama RÜPPELL, Reise, Nord. Afrika, Atlas (1826–31) 9, pl. 3, fig. 1; GÜNTHER, Cat. Fish. Brit. Mus. 2 (1860) 243; KLUNZINGER, Abh. Zool. Bot. Ges. Wien 20 (1870) 818; Sitzber. Akad. Wien (1880) 369; Fische Rothen Meeres (1884) 123; BLEEKER, Verh. Akad. Ams. 14 [(1873) 1874] 67; Atlas, Ichth. 9 (1877) pl. 389, fig. 4; DAY, Fish. India (1878–1888) 265; STEINDACHNER and DÖDERLEIN, Denkschr. Akad. Wien 49 (1884) 192; JORDAN and SNYDER, Proc. U. S. Nat. Mus. 24 (1902) 486; GILCHRIST and THOMPSON, Ann. South Afric. Mus. 6 pt. 2 (1908) 192; FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1922) 68; CHAUDHURI, Mem. Indian Mus. 5 (1923) 721; BARNARD, Ann. South Afric. Mus. 21 (1925–27) 507; FOWLER, Mem. Bishop Mus. 10 (1928) 235; WEBER and DE BEAUFORT, Fishes Indo-Austr. Arch. 6 (1931) 172, fig. 33; FOWLER, Bull. No. 100, U. S. Nat. Mus. 12 (1933) 417.

Dorsal XI–I, 20 to 22; anal II, 21 to 23; scales on lateral line to base of caudal 68 to 70; between lateral line and origin of dorsal 5; between lateral line and origin of anal 11.

Body slender and slightly compressed, its depth 5.2 to 6.1 in length; dorsal profile not much elevated, with the anterior portion rising evenly and gently from snout to dorsal fin; ventral outline nearly straight; head elongate, 3.2 to 3.9 in length of body; caudal peduncle narrow and short, its least depth 3.2 to 4.2 in head; interorbital space slightly convex, 4.9 to 6 in head;

eye large and ellipsoidal, located midway between tip of snout and posterior edge of preopercle, its maximum diameter 3.2 to 4.3 in the head; snout long and pointed, nearly twice as long as the maxillary, which is 4.1 to 5 in head; greatest width of preorbital very slightly exceeding the diameter of eye, 2.9 to 3.5 in head; mouth small, somewhat oblique, with the upper jaw a trifle the longer; teeth villiform in both jaws, those in the outer row slightly enlarged and directed inward; a broad patch of vomerine teeth present.

Body, nape, and opercle covered with finely ctenoid scales; those on preopercle and throat cycloid, on frontal cycloid and ctenoid; cheeks with two rows of cycloid scales, sometimes with small ones between; proximal two-thirds of supraorbital with four to five rows of very small ctenoid scales and the rest of head naked; all fins scaly; dorsals separate, the first one higher than the second and inserted on a line passing a little behind base of ventrals; origin of second or rayed dorsal opposite that of anal, both fins about equal in length; pectoral 1.7 to 1.9 in head and almost as long as ventral, both fins pointed; caudal emarginate.

Ground color of fresh specimens greenish olive, washed with grayish above lateral line from nape to caudal peduncle and becoming light silvery white below; an indistinct silvery yellowish longitudinal band below lateral line on posterior two-thirds of body; top of head to tip of snout dusky; preorbital grayish above and yellowish below; lower jaw, posterior half of premaxillary, cheek, and upper half of opercle yellow; spinous dorsal dotted with blackish and tipped with black to the sixth or eighth spine; soft dorsal tipped with blackish, the minute dots on membrane forming a blackish vertical band in front of each ray; pectoral yellowish gray; ventral and anal yellowish; caudal yellowish, with a broad margin of blackish above, below, and behind.

Alcoholic specimens slightly yellowish to brownish, generally lighter to dull silvery white at belly and grayish above lateral line from occiput to caudal peduncle; in many specimens a faint trace of dull silvery white longitudinal band present on posterior half of side to middle portion of caudal peduncle, in some it is absent; spinous and soft dorsals finely dotted with grayish and with blackish narrow edge; caudal yellowish, with outward portions of rays grayish; other fins yellowish.

Fifty specimens were examined, varying from 58 to 290 millimeters in length. They were collected at the following localities:

LUZON, Cagayan Province, Abulog: Ilocos Norte Province, Bangui: Ilocos Sur Province, Vigan: Zambales Province, Iba, Subic: Pampanga Province, Macabebe: Bulacan Province, Paombong: Manila: Rizal Province, Pasay: Batangas Province, Nasugbu, Balayan Bay: Camarines Sur Province, Sibubu, San Miguel Bay: Albay Province, Legaspi. MINDORO, Mindoro Province, Pinamalayan. SAMAR, Samar Province, San Pedro Bay. LEYTE, Leyte Province, Dulag, Carigara. PANAY, Iloilo Province, Barotac Nuevo, La Paz, Molo, Zarraga. NEGROS, Negros Oriental Province, Tanjay. PALAWAN, Palawan Province, Guinlo, Puerto Princesa, Panacan. MINDANAO, Agusan Province, Agusan: Misamis Province, Cagayan: Davao Province, Davao.

This species is common in the Philippines and occurs from the Red Sea through seas of India to the Malay Archipelago, ranging northward to China, Japan, and Korea, and eastward to Samoa. It ascends tidal waters and reaches a length of more than one foot. It has been recorded by Günther from the Philippine Islands, by Jordan and Seale from Cavite and Negros Island, and by Jordan and Richardson from Aparri.

SILLAGO MACULATA Quoy and Gaimard. Plate 1, fig. 2.

Sillago maculata QUOY and GAIMARD, Voy. Uranie et Physicienne (1824) 261, pl. 53, fig. 2; CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 303; BLEEKER, Verh. Bat. Gen. 22 (1849) 62; Verh. Akad. Ams. 14 (1874) 71; Nat. Tijdschr. Ned. Indië 13 (1858–59) 161; Verh. Akad. Ams. 14 [(1873) 1874] 71; Atlas Ichth. 9 (1877) 389, fig. 5; GÜNTHER, Cat. Fish. Brit. Mus. 2 (1860) 245; KNER, Novara-Exp. Fische (1865–67) 127; DAY, Fishes of India (1878) 265; MACLEAY, Descr. Cat. Austr. Fish. 1 (1881) 201; MCCULLOCH, Austr. Zool. 1 (1919) 51; BARNARD, Ann. S. African Mus. 21 (1925–28) 508; WEBER and DE BEAUFORT, Fishes Indo-Austr. Arch. 6 (1931) 174; FOWLER, U. S. Nat. Mus. Bull. No. 100 12 (1933) 423.

Sillago burrus RICHARDSON, Icon. Piscium (1843) 5.

Sillago gracilis ALLEYNE and MACLEAY, Proc. Linn. Soc. N. S. W. 1 (1877) 279, pl. 6, fig. 2.

Dorsal XI–I, 19; anal II, 17 or 18; scales on lateral line to base of caudal 69; between lateral line and origin of dorsal 6; between lateral line and origin of anal 13.

Body elongate and slightly compressed, with dorsal outline fairly well arched and ventral contour nearly straight; depth 4.5 to 5.2 in length; greatest depth of head nearly twice in its length which is 3.2 to 3.4 in that of body; caudal peduncle narrow and compressed, its least depth 3.4 to 3.9 in head; interorbital space slightly convex, 5 to 5.6 in head; eye large and ellipsoidal, located closer to posterior edge of opercle than to tip of snout, its maximum diameter 3.3 to 3.6 in head; snout rather pointed, 2.4 to 2.5 in head; maxillary a little shorter than eye, being 4 to 4.4 in head and reaching to nearly halfway below front edge of eye; greatest width of preorbital 2.9 to 3.2 in head; mouth small and slightly oblique, with the upper jaw a trifle the longer; teeth villiform in both jaws, the outer row a little enlarged and curved inward; a band of teeth on vomer; vertical limb of preopercle finely serrated; opercle with a small spine behind.

Scales on body, nape, and opercle ctenoid, those on cheek ctenoid, in four rows; scales on preopercle and throat cycloid, on frontal both cycloid and ctenoid; a patch of fine scales on supraorbital; scales also present on all fins; first dorsal higher than the second, its spines weak and decreasing in height from the second which is 1.9 to 2.6 in head, pectoral 1.6 to 2 in head; ventral a little shorter than pectoral; caudal forked.

Ground color in alcohol yellowish to brownish, slightly grayish along back, becoming dull white on abdomen; some irregular blackish blotches on sides; a dull silvery longitudinal band running from above base of pectoral to caudal peduncle; upper half of spinous dorsal blackish; outer edges of soft dorsal blackish, the rest of fin with two longitudinal bands of like color; caudal washed with grayish behind; other fins colorless.

The above description is taken from five specimens, 90.5 to 147.7 millimeters in length, collected from the following places:

LUZON, Manila. LEYTE, Leyte Province, Tacloban. PANAY, Iloilo Province, Estancia. PALAWAN, Palawan Province, Panacan.

This well-marked species ranges from the Andamans, through the Malay Archipelago, to the southeast of Australia. It is said to attain 8 or 9 inches in length.

This fish has been reported by Kner from Manila.

SILLAGO ARGENTIFASCIATA sp. nov. Plate 1, fig. 3.

Dorsal XI–I, 17 or 18; anal II, 17; scales on lateral line to base of caudal 66; between lateral line and origin of dorsal 5; between lateral line and origin of anal 9.

Body slender, a little compressed, its depth 4.9 to 5.3 in length; dorsal and ventral profiles evenly and almost equally arched, the deepest portion at origin of second dorsal and anal; head elongate, rather sharply pointed, 3.3 to 3.4 in length of body; caudal peduncle compressed, its least depth 11.6 to 12.1 in length of body, 3.4 to 3.6 in head; eye large and ellipsoidal, located slightly nearer posterior edge of opercle than tip of snout, its maximum diameter 3.4 to 3.5 in head; interorbital space flat, almost 2 in snout and 5.5 to 5.6 in head; snout pointed, 2.4 to 2.6 in head, its upper outline very slightly arched; maxillary 4.3 to 4.9 in head and 1.8 to 1.9 in snout, ending behind halfway between tip of snout and vertical through anterior edge of eye; greatest width of preorbital 2.9 to 3.4 in head; mouth small and slightly oblique; lower jaw a little included; vertical limb of preopercle serrated; teeth villiform in both jaws, those in outer row enlarged and bent forward; a band of teeth on vomer.

Body, nape, and opercle covered with finely ctenoid scales; cheek with three rows of scales, those on upper row cycloid and on lower two rows ctenoid; preopercle and throat with cycloid scales; frontal scales both cycloid and ctenoid; caudal scaly, rest of fins naked; a patch of small scales present on supraorbital; dorsal spines decreasing in height to the last, the first one 2.2 to 2.4 in head; pectoral longer than ventral, 1.7 to 1.8 in head; caudal deeply forked.

Ground color in alcohol dull silvery white; a well-pronounced, brilliant, silvery, longitudinal band, widest between the anterior portions of anal and second dorsal, runs on side from above base of pectoral to base of caudal; anteriorly this band is below the lateral line and posteriorly its upper edge touches it; breast and opercle brilliant silvery; upper portion of each dorsal spine and ray sparsely dotted with blackish; all other fins hyaline.

This species is distinct in having three rows of scales on the cheek and a wide, brilliant, silvery, longitudinal band on each side of the body.

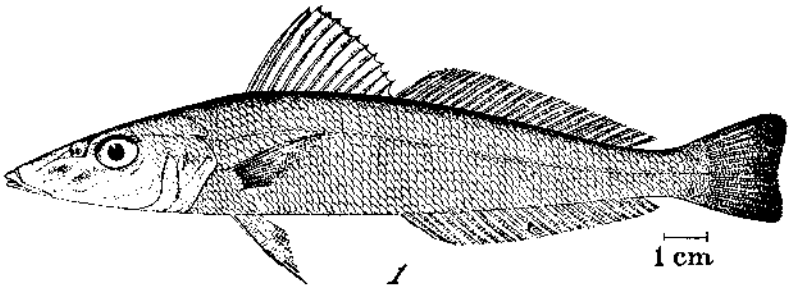
Here described from the type, No. 15680. Cotypes, Nos. 31146 and 31147, all deposited in the collection of the Fish and Game Administration; all obtained November 29, 1927, at Lumbucan Island, Palawan. The three specimens range in size from 81.8 to 116.3 millimeters.

Argentifasciata, silver-banded.

ILLUSTRATION

PLATE 1

FIG. 1. *Sillago sihama* (Forskål); natural size. Drawn by Pablo Bravo.
2. *Sillago maculata* (Quoy and Gaimard); natural size. Drawn by Antonio Canlas.
3. *Sillago argentifasciata* sp. nov.; natural size. Drawn by Pablo Bravo.



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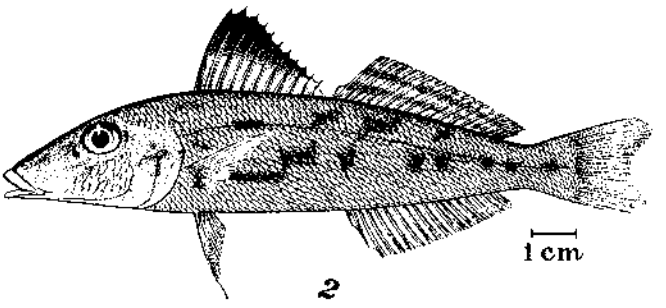

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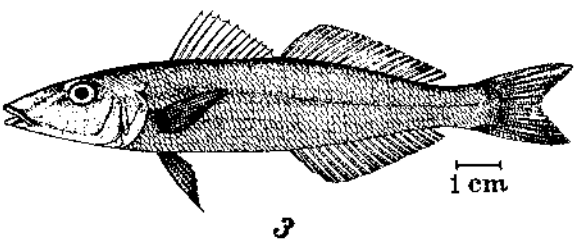

3

PLATE 1.

A REVIEW OF PHILIPPINE ISOSPONDYLOUS FISHES

By HILARIO A. ROXAS

Of the Fish and Game Administration, Bureau of Science, Manila

THREE PLATES

Although the isospondylous fishes comprise some of the most important food fishes of the Philippines and are encountered in the market the year around, nothing extensive on their taxonomy has been written. In the collection of the Fish and Game Administration are numerous examples of fishes belonging to this order, which have been gathered from various parts of the Archipelago by various persons since 1907. An attempt is made here to present a systematic record of this material, so that the confusion arising from wrong identification and from nonuniformity of taxonomic treatment may be partially if not completely eliminated. Günther (1887), Smith and Seale (1906), Jordan and Seale (1907), Evermann and Seale (1907), Seale and Bean (1907), Jordan and Richardson (1908), Fowler (1918, 1931), and Herre (1927, 1934) mentioned some of the species of this order. This is the first time, however, that detailed descriptions and complete synonyms of all the Philippine representatives of the group are given in one paper.

This is the second paper dealing with the systematics of Philippine fishes that are of economic or commercial importance. As is mentioned in a previous paper (Roxas, 1934), these studies on taxonomy have to be made before the breeding habits, life histories, and feeding habits of these animals can be adequately studied.

The isospondylous fishes are bony fishes whose fins do not possess true spines, being provided mostly with soft fin rays. The ventral fins, if present, are always abdominal in position. The tail is homocercal, but the hæmal supports are fused or not much expanded. The opercle is well developed, and its bones are complete. The pectoral arches are suspended from the cranium. In the living (nonextinct) forms the air bladder is connected with the œsophagus in the adult. The spiral value of the intestine is either incomplete or wanting.

Previously reported examples of isospondylous fishes in the Philippines belong to twelve families, thirty genera, and fifty-one species, as shown in the following check list:

ELOPIDÆ

ELOPS HAWAIENSIS Regan.

Elops saurus Evermann and Seale (1906) Bulan; Jordan and Richardson (1907) Manila.

Elops hawaiiensis Fowler (1918) Philippines; Herre (1934) Manila, Capiz, and Dumaguete.

Elops hawaiensis Fowler (1927) Orani.

MEGALOPS CYPRINOIDES (Brussonet).

Megalops cyprinoides Jordan and Seale (1905) Negros; Evermann and Seale (1906) Bulan; Weber and de Beaufort (1913) Philippines; Fowler (1918) Philippines; Fowler (1927) Vigan, Orion, Philippines; Herre (1934) Bauang Sur, Bulacan, Manila.

ALBULIDÆ

ALBULA VULPES (Linnæus).

Albula vulpes Herre (1934) Jolo.

CHANIDÆ

CHANOS CHANOS (Forskål).

Chanos chanos Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Manila; Evermann and Seale (1907) Manila; Seale and Bean (1907) Zamboanga; Fowler (1918) Philippines; Fowler (1927) San Fernando, Vigan, Orani, Philippines; Herre (1934) Bulacan, Malabon, Cavite, Capiz, La Paz (Iloilo), Dumaguete.

CHIROCENTRIDÆ

CHIROCENTRUS DORAB (Forskål).

Chirocentrus dorab Jordan and Seale (1906) Cavite; Evermann and Seale (1906) San Fabian, Bacon; Jordan and Richardson (1907) Manila; Weber and de Beaufort (1913) Philippines; Fowler (1918) Philippines; Fowler (1922) Cebu; Fowler (1927) Vigan; Herre (1934) Unisan, Capiz, Cebu, Dumaguete, Jolo.

DUSSUMIERIIDÆ

SPRATELLOIDES GRACILIS (Schlegel).

Stolephorus gracilis Evermann and Seale (1906) Bacon.

Spratelloides gracilis Weber and de Beaufort (1913) Philippines.

SPRATELLOIDES DELICATULUS (Bennett).

Stolephorus delicatulus Evermann and Seale (1906) Bacon and Bulan; Fowler (1927) Bacon.

Spratelloides delicatulus Weber and de Beaufort (1913) Philippines; Herre (1934) Calapan, Culion, Dumaguete.

DUSSUMIERIA ACUTA Cuvier and Valenciennes.

Dussumieria acuta Kner (1865) Manila; Weber and de Beaufort (1913) Philippines; Fowler and Bean (1922) Cebu; Deraniyagala (1929) Philippines.

Dussumieria elopsoides Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Iloilo.

DUSSUMIERIA HASSELTII Blecker.

Dussumieria hasseltii Jordan and Richardson (1907) Manila; Weber and de Beaufort (1913) Philippines; Fowler (1918) Philippines; Fowler (1927) San Fernando, Orani, Orion, Philippines; Herre (1934) Gulf of Lingayen, La Union Province, Unisan, La Paz, (Iloilo), Cebu.

ETRUMEUS ALBULINA Fowler.

Etrumeus albulina Fowler (1934) Iloilo.

DOROSOMIDÆ

NEMATALOSA NASUS (Bloch).

Konosirus thrissa Evermann and Seale (1906) Philippines; Herre (1934) Sitanki.

Konosirus nasus Seale and Bean (1907) Zamboanga.

Dorosoma nasus Weber and de Beaufort (1913) Philippines.

Nematalosa nasus Herre (1934) Culion.

ANODONTOSTOMA CHACUNDA (Hamilton-Buchanan).

Anodontostoma chacunda Evermann and Seale (1906) Bacon; Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Manila and Iloilo; Fowler (1918) Philippines; Fowler (1927) San Fernando, Santa Maria, Orani, Orion, Philippines; Fowler (1931) Philippines; Herre (1934) Bauang Sur, Manila.

Dorosoma chacunda Weber and de Beaufort (1913) Philippines.

ENGRAULIDÆ

THRISSINA BÆLAMA (Forskål).

Anchovia baelama Jordan and Richardson (1907) Cagayancillo and Iloilo; Seale and Bean (1907) Zamboanga.

Engraulis baelama Weber and de Beaufort (1913) Philippines; Fowler (1927) Sta. Maria.

Thrissina baelama Herre (1934) Capiz, Cebu, Cotabato.

SCUTENGRAULIS HAMILTONII (Gray).

Engraulis hamiltonii (1907) Manila, Iloilo; Fowler (1927) Philippines.

Engraulis grayi Weber and de Beaufort (1913) Philippines.

THRISSOCLES SETIROSTRIS (Broussonet).

Anchovia setirostris Jordan and Richardson (1907) Aparri.

Engraulis setirostris Weber and de Beaufort (1913) Philippines; Fowler (1927) Philippines.

Thrissocles setirostris Fowler (1931) Philippines; Herre (1934) Bauang Sur, Capiz.

ENGRAULIS DUSSUMIERI Cuvier and Valenciennes.

Engraulis dussumieri Herre (1934) Dumaguete.

ENGRAULIS VALENCIENNESI (Bleeker).

Engraulis valenciennesi Fowler (1927) Orani.

STOLEPHORUS HETEROLOBUS Rüppell.

Stolephorus heterolobus Herre (1934) Dumaguete.

STOLEPHORUS COMMERSONII Lacépède.

Anchovia commersoniana Jordan and Seale (1906) Cavite.
Anchovia commersonii Fowler (1918) Philippines; Fowler (1927) San Fernando, Bangued, Sta. Maria, Vigan, Philippines.
Scutengraulis commersonii Fowler (1931) Philippines.
Stolephorus commersoni Herre (1934) Bauang Sur, Dumaguete.

STOLEPHORUS INDICUS (van Hasselt).

Anchovia indica Jordan and Seale (1906) Cavite; Evermann and Seale (1906) Bulan.
Engraulis indicus Fowler (1927) Orion, Philippines.
Stolephorus indicus Weber and de Beaufort (1913) Philippines; Herre (1934) Cebu, Dumaguete, Atimonan.
Scutengraulis indica Fowler (1931) Philippines.

STOLEPHORUS TRI (Bleeker).

Stolephorus tri Weber and de Beaufort (1913) Philippines; Herre (1934) Bauang Sur, Manila, Cotabato.
Engraulis tri Fowler (1927) Sta. Maria, Orion, Orani, Philippines.
Scutengraulis tri Fowler (1931) Philippines.

CLUPEIDÆ

CLUPEOIDES LILE (Cuvier and Valenciennes).

Clupeoides lile Herre (1934) Unisan, Dumaguete.

SARDINELLA LEIOGASTER Cuvier and Valenciennes.

Sardinella leiogaster Herre (1934) Jolo.

SARDINELLA CLUPEOIDES (Bleeker).

Sardinella clupeoides Evermann and Seale (1906) Bulan; Herre (1934) Culion.
Clupea (*Amblygaster*) *clupeoides* Weber and de Beaufort (1913) Philippines.

SARDINELLA SIRM (Rüppell).

Clupea (*Amblygaster*) *sirm* Weber and de Beaufort (1913) Philippines.
Sardinella sirm Fowler (1931) Philippines; Herre (1934) Dumaguete.

SARDINELLA BRACHYSOMA (Bleeker).

Sardinella brachysoma Fowler (1927) Sta. Maria, Orani, Orion; Fowler (1931) Philippines.

SARDINELLA MELANURA (Cuvier and Valenciennes).

Harengula vanicoris Jordan and Seale (1906) Philippines.

Clupea melanura Seale and Bean (1907) Zamboanga.

Clupea (Harengula) melanura Weber and de Beaufort (1913) Philippines.

Sardinella melanura Fowler (1927) Vigan, Sta. Maria; Herre (1934) Cape Bolinao, Pangasinan.

SARDINELLA PERFORATA (Cantor).

Sardinella perforata Evermann and Seale (1906) Bacon; Fowler (1931) Philippines; Herre (1934) Manila.

Clupea (Harengula) perforata Weber and de Beaufort (1913) Philippines.

SARDINELLA FIMBRIATA (Cuvier and Valenciennes).

Harengula gibbosa Jordan and Seale (1906) Negros; Jordan and Richardson (1907) Manila.

Harengula sundaica Jordan and Richardson (1907) Manila, Iloilo, Aparri.

Clupea (Harengula) fimbriata Weber and de Beaufort (1913) Philippines.

Clupea (Harengula) fimbriata Deraniyagala (1929) Philippines.

Sardinella fimbriata Fowler (1918) Philippines; Fowler (1927) Bacon; Fowler (1931) Philippines; Herre (1934) Bauang Sur, Manila, Nasugbu, Alabat Islands.

SARDINELLA LONGICEPS Cuvier and Valenciennes.

Sardinella longiceps Fowler (1927) Orion; Herre (1931) Estancia, Culion, Manila market.

SARDINELLA SCHRAMMI (Bleeker).

Harengula schrammi Fowler (1927) Sta. Maria, Vigan, San Fernando; Herre (1934) Dumaguete.

SARDINELLA JUSSIEU (Lacépède).

Sardinella jussieu Fowler (1927) Vigan; Orani, Orion; Philippines.

HARENGULA DISPILONOTUS Bleeker.

Harengula dispilonotus Herre (1931) Cebu; Fowler (1934) Philippines.

HARENGULA TAWILIS Herre.

Harengula tawilis Herre (1927) Lake Taal; Herre (1934) Lake Bombon.

HARENGULA MOLUCCENSIS Bleeker.

Harengula moluccensis Jordan and Seale (1906) Cavite; Evermann and Seale (1906) Bacon, Bulan; Jordan and Richardson (1907) Manila; Seale and Bean (1907) Zamboanga; Herre (1934) Jolo, Dumaguete.

Clupea (Harengula) moluccensis Weber and de Beaufort (1913) Philippines.

Harengula punctata Herre (1934) Unisan, Culion, Dumaguete.

ILISHA HOEVENII Bleeker.

Ilisha hoevenii Evermann and Seale (1906) San Fabian; Jordan and Seale (1906) Cavite; Jordan and Richardson (1907) Manila; Fowler (1918) Philippines; Fowler (1927) Orion, Philippines; Herre (1934) Manila.

Pellona hoevenii Weber and de Beaufort (1913) Philippines.

ILISHA DITCHOA Cuvier and Valenciennes.

Pellona ditchoa Herre (1934) La Paz, Iloilo.

ALEPOCEPHALIDÆ

ALEPOCEPHALUS ANDERSONI Fowler.

Alepocephalus andersoni Fowler (1934) between Siquijor and Bohol in 392 fathoms.

BATHYTROCTES HATAII Fowler.

Bathytroctes hataii Fowler (1934) east coast of Luzon; in 300 fathoms.

NARCETES LLOYDI Fowler.

Bathytroctes lloydi Fowler (1934) east coast of Luzon, in 565 fathoms.

NARCETES GARMANI Fowler.

Narcetes garmani Fowler (1934) China Sea, vicinity of southern Luzon, in 248 fathoms.

MICROSTOMIDÆ

MICROSTOMA SCHMITTI Fowler.

Microstoma schmitti Fowler (1934) east coast of Luzon, in 383 fathoms.

STERNOPTYCHIDÆ

POLYIPNUS SPINOSUS Günther.

Polyipnus spinosus Günther (1887) Sta. 200, between the Philippine Islands and Borneo.

STERNOPTYX DIAPHANA Hermann.

Sternoptyx diaphana Günther (1887) Sta. 214, Philippine Islands.

STOMIATIDÆ

STOMIAS AFFINIS Günther.

Stomias affinis Günther (1887) Sta. 23, South of Sombrero Island, Philippines.

MALACOSTEUS INDICUS Günther.

Malacosteus indicus Günther (1887) Sta. 214, near Philippine Islands.

ELAPTEROSTOMIAS PHILIPPINUS Fowler.

Elapterostomias philippinus Fowler (1934) China Sea, vicinity of southern Luzon, in 524 fathoms.

PSEUDOEUSTOMIAS MYERSI Fowler.

Pseudoeustomias myersi Fowler (1934) Sulu Sea, vicinity of southern Panay, in 411 fathoms.

MELANOSTOMIAS STEWARTI Fowler.

Melanostomias stewarti Fowler (1934) Dupon Bay, Leyte.

MELANOSTOMIAS GLOBULIFER Fowler.

Melanostomias globulifer Fowler (1934) west coast of Luzon, in 297 fathoms.

MELANOSTOMIAS VIERECKI Fowler.

Melanostomias vierecki Fowler (1934) east of Masbate, in 604 fathoms.

The following species previously accredited to the Philippine Islands are not represented in the collection of the Fish and Game Administration, Bureau of Science.

Spratelloides gracilis (Schlegel).
Engraulis dussumieri Cuvier and Valenciennes.
Engraulis valenciennesi Fowler.
Etrumeus albulina Fowler.
Stolephorus heterolobus Rüppell.
Sardinella leiogaster Cuvier and Valenciennes.
Sardinella clupeoides (Bleeker).
Sardinella brachysoma (Bleeker).
Sardinella schrammi (Bleeker).
Ilisha ditchoa Cuvier and Valenciennes.
Alepocephalus andersoni Fowler.
Bathytroctes hataii Fowler.
Narcetes lloydi Fowler.
Narcetes garmani Fowler.
Microstoma schmitti Fowler.
Polyipnus spinosus Günther.
Stomias affinis Günther.
Malacosteus indicus Günther.
Elapterostomias philippinus Fowler.
Pseudoeustomias myersi Fowler.
Melanostomias stewarti Fowler.
Melanostomias globulifer Fowler.

Scutengraulis mystax (Bloch) and *Valenciennellus tripunctulatus* (Esmark) are recorded in the Philippines for the first time.

A new species of *Sardinella* is described in this paper.

Key to the Philippine families of the order.

a^1. Lateral line present.
  b^1. Gular plate present between branches of lower jaw..... ELOPIDÆ.
  b^2. No gular plate.
    c^1. Teeth present ..... ALBULIDÆ.
    c^2. Teeth absent ..... CHANIDÆ.

a^2. No lateral line.
b^1. No adipose fin; no photophores; parietals present.
c^1. Abdominal edge without scutes.
d^1. Belly carinate, sharp; teeth long; scales very small. CHIROCENTRIDÆ.
d^2. Belly rounded, teeth short; scales moderate..... DUSSUMIERIIDÆ.
c^2. Abdominal edge with scutes.
d^1. Mouth small, inferior; maxillary with one supplemental bone; no teeth ..... DOROSOMIDÆ.
d^2. Mouth large; maxillary with two supplemental bones; teeth usually present.
e^1. Snout prominent; mouth usually oblique, maxillary narrow, may be produced ..... ENGRAULIDÆ.
e^2. Snout never prominent, mouth horizontal, terminal; maxillary broad, never produced ..... CLUPEIDÆ.
b^2. Adipose fin present; photophores present; parietals absent. STERNOPTYCHIDÆ.

ELOPIDÆ

Body oblong or elongate, more or less compressed. Scales cycloid and silvery. Mouth large and terminal, bounded laterally by maxillaries which have two supplemental bones. Intermaxillaries short and nonprotractile. A gular plate present between mandibular branches. A straight lateral line present. Dorsal slightly behind origin of ventrals; anal far behind dorsal. Pectorals situated low and can be folded like ventrals. Gill rakers 13 to 30. Gill membranes free and separate. Branchiostegals numerous.

This family is represented in the collection by two genera, *Elops* Linnæus and *Megalops* Lacépède, each with one species.

In the genus *Elops*, large pseudobranchiæ are present; the dorsal and the anal are depressible in a scaly sheet; the dorsal is longer than the anal, without produced rays; the scales are small. In the genus *Megalops* no pseudobranchiæ are present; the dorsal and the anal are not provided with a scaly sheet; the dorsal is shorter than the anal, its last ray produced, and the scales are large and heavy.

ELOPS HAWAIENSIS Regan. Bidbid, awa. Plate 1, fig. 11.

Elops saurus BLEEKER, Atl. Ichth. 6 (1866–1872) 84; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 594; FOWLER, Proc. Acad. Nat. Sci. Phila. (1900) 496; STEINDACHNER, Denk. Akad. Wiss. Wien 70 (1901) 513; JENKINS, Bull. U. S. Fish Comm. 22 (1902) 432; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 53; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 235.

Elops hawaiensis REGAN, Ann. & Mag. Nat. Hist. III 8 (1909) 39; GÜNTHER, Journ. Mus. Godeffroy 8 pt. 16 (1910) 386; FOWLER, Proc.

Acad. Nat. Sci. Phila. (1911) 204; WEBER, Fische Siboga Expeditie (1913) 1; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 3; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; Mem. B. P. Bishop Mus. 10 (1928) 26.

Elops hawaiiensis FOWLER, Copeia No. 58 (June, 1918) 62; No. 112 (November, 1922) 82; Bull. B. P. Bishop Mus. 22 (1925); HERRE, Fish. Herre 1931 Philip. Exp. (1934) 13.

Head 3.4–3.7; depth 5.5–5.7; dorsal 23–24; anal 15–16; scales 94–97 in lateral line, 22–25 in transverse series, 10–12 above lateral line.

Body elongate, compressed. Head broad, about 3 in its length. Mouth large, oblique, inferior; jaws of equal length. Snout width about its length, equal eye. Maxillary narrow at origin, broad distally, greatest breadth about radius of eye; extends far behind hind margin of eye. Fine villiform teeth on jaws, entire inferior margin of maxillary, tongue, vomer, palatines, and pterygoids. Entire premaxillary teeth exposed when mouth is closed. Length of gular plate less than twice the orbit. Dorsal surface of head furrowed at center; interorbital less than eye. Radiating venules on preopercle and opercle. Four large, thin, soft scales behind occiput, the lateral pair overlapping opercle. About 30 branchiostegals, left wing overlapping right at isthmus. Gill rakers 13 to 15, hard, flattened, with spinous edge; length about equal to gill filament and to radius of eye. Pseudobranchiæ well developed, about 40. Scales minute, rather adherent, with 9 to 15 radii which terminate on basal margin on indentations; posterior margin serrate, crenulate. Scales on lateral line with closed tube on focus.

Origin of dorsal nearer caudal base than snout tip, depressible in scaly sheath; base about equal to postocular part of head, shorter than its height. Anal short, depressible in scaly sheath, shorter than height, slightly longer than greatest width of operculum, well advanced from caudal base. Pectorals equal dorsal base. Ventrals well developed, slightly shorter than pectorals, nearer anal than pectorals and below first fourth of dorsal base.

This description is based on two specimens, Nos. 15137 and 24349, 217 mm and 192 mm long, obtained from Manila December 9, 1926.

MEGALOPS CYPRINOIDES (Broussonet) **Buanbuan, bulan-bulan. Plate 1, fig. 4.**

Clupea cyprinoides BROUSSONET, Tableau Ichth. Lichtenstein, Forster, Descript. anim. (1844) 296.

Megalops indicus BLEEKER, Journ. Ind. Arch. 3 (1849) 67; KNER, Fische Novara Exp. (1865–67) 339.
Elops cundinga CANTOR, Journ. Asiat. Soc. Bengal 18 (1850) 1271.
Megalops macrophthalmus BLEEKER, Nat. Tijdschr. Ned. Ind. 1 (1851) 421.
Megalops cyprinoides GÜNTHER, Cat. Brit. Mus. 7 (1868) 471; BLEEKER, Atl. Ichth. 6 (1866–72) 87; DAY, Fishes of India 4°. (1878–88) 650; SAUVAGE, Hist. Madagascar 16 (1891) 495; JORDAN and SEALE, Proc. U. S. Nat. Mus. 18 (1905); EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 53; GÜNTHER, Fische der Südsee 8 (1909) 387; WEBER, Fische Siboga Expeditie (1913) 1; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 5; CHAUDHURI, Mem. Ind. Mus. 5 (1916) 417; FOWLER, Copeia No. 58 (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; SCHMIDT, Pan-Pacific Res. Inst. 5 No. 4 (1930) 2; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 13.
Megalops macropterus MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 594.
Clupea thrissocles SCHNEIDER, Bloch, Syst. Ichth. (1801) 424.
Clupea setipinna VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 286.

Head 3.3–3.6; depth 3.3–3.4; dorsal 17–19; anal 23–25; scales 34–36 in longitudinal series along lateral line; 12 in transverse series, 5 above lateral line; 15–17 predorsals.

Body oblong, compressed, ventral profile more convex than dorsal; belly noncultrate. Head width 2.3 to 2.4 in its length. Mouth large; lower jaw prominent, longer than upper; maxillary large, narrow at fusion with premaxillary, more or less uniformly broad posteriorly and ending bluntly on or slightly behind hind border of eye; length equals preocular part of head minus lower jaw. Snout short, about 1.4 in eye which is large and about 3.4 to 3.5 in head. Minute villiform teeth on jaws, along entire inferior border of maxillary, tongue, palatine, vomer, and pterygoid. Interorbital flat, narrower than snout, equal snout length. Branchiostegals 22 to 24, right wing rolled in, invariably overlapped by left wing at region of isthmus. Gill rakers 30 to 31, longer than filaments, less than radius of orbit, strong, flat, blunt, with spines on inner edge. Scales large, adherent, with peculiar lobate basal margin; with 4 to 8 prominent radii which end posteriorly on indentations of anterior margin; with several indistinct and broken transverse striations which may anastomose with radii; posterior margin thin, crenulate; scales on lateral line with large furrows on exposed portion radiating from foci.

Dorsal origin nearer caudal base than snout tip; last ray produced, not reaching caudal base, 1.7 to 2.2 times dorsal base which is about 1.5 in its height. Anal long, shorter than produced dorsal ray, longer than high; last ray barely reaching caudal base. Pectorals about equal anal base, 1.4 to 1.6 in head. Ventrals about equal dorsal base, nearer anal origin than pectorals, immediately below dorsal origin.

This description is based on No. 10048, 127 mm, obtained from Zambales, October 20, 1921, and No. 15141, 192 mm, obtained from Lake Bombon, Batangas, August 18, 1927.

LUZON, Cagayan Province, Buguey, No. 28186, 124 mm; Pampanga Province, Guagua, No. 15290, 181 mm, April 8, 1927; Macabebe, Nos. 15337, 28193–4, 168 to 183 mm, May 6, 1927; Tarlac Province, Tarlac, No. 4132, 223 mm, 1904; Zambales Province, Iba, No. 10048, 130 mm, October 20, 1921; Bulacan Province, Obando, sitio Pagogo, No. 15335, 143 mm, April 2, 1927; Paombong, No. 15336, 15 mm, April 22, 1927; Rizal Province, Pasay, No. 543, 162 mm, July 7, 1907; Manila, Nos. 302, 162 mm, June 14, 1907; No. 950, 207 mm, September, 1907; Albay Province, Legaspi, Rawis River, Nos. 13075 and 28288–89, 35 to 79 mm, February 2–3, 1926. MINDORO, Mindoro Province, Mangarin Bay, No. 9645, 128 mm, 1913; Puerto Galera, Nos. 10079, 28188–89, 110 to 140 mm, March–May, 1912. GUIMARAS, Iloilo Province, Jordan, Nos. 11630, 28187, 80 to 86 mm, February 7, 1925. NEGROS, Negros Oriental Province, Dumaguete, No. 15971, 55 mm, March, 1913. PALAWAN, Palawan Province, Taytay, Nos. 10079, 28190–92, 90 to 175 mm, May, 1913. BALABAC, Palawan Province, No. 15697, 168 mm, November 17, 1927. CAMIGUIN, Misamis Province, No. 583, 202 mm, July 20, 1907.

ALBULIDÆ

Body elongate, slightly compressed; abdominal surface rounded, not keeled. Head naked. Snout prominent, conical, long, projecting beyond cleft of mouth which is inferior and horizontal. Maxillary edentulous with one supplemental bone. Villiform teeth on jaws, vomer, and palatines; granular teeth on pterygoids, sphenoid, and tongue. Eye large, with broad annular adipose covering. Gular plate wanting. A collar of thin, flappy scales on occiput. Gill membranes separate, free from isthmus. Gill rakers short, granular. Scales small, ad-

herent, cycloid, with a brilliant silvery sheen. Lateral line present. Dorsal slightly in advance of ventrals. Anal short, less than base of dorsal, far behind anus. Caudal deeply forked. Large axillary scales above and below ventrals. Branchiostegals 11 to 16. Pseudobranchiæ well developed.

Genus ALBULA Bloch

For characters of the single genus see those of the family. One Philippine species is known.

ALBULA VULPES (Linnæus). Plate 1, fig. 12.

Esox vulpes LINNÆUS, Syst. Nat. ed. 10 (1758) 313.

Argentina glossodonta FORSKÅL, Descript. anim. (1777) 68; BONNATERRE, Ency. Ichth. (1752–1804) 177; GMELIN, Linn. Syst. Nat. (1748–1804) 1394.

Esox argenteus SCHNEIDER, Bloch, Syst. Ichth. (1801) 395; LICHTENSTEIN, Forster, Descript. anim. (1844) 196, 256.

Synodus argenteus SCHNEIDER, Bloch, Syst. Ichth. (1801) 398.

Clupea Brasiliensis SCHNEIDER, Bloch, Syst. Ichth. (1801) 427.

Amia immaculata SCHNEIDER, Bloch, Syst. Ichth. (1801) 451.

Butirinus bonanus LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 45; CUVIER and VALENCIENNES, Hist. Nat. Poiss. 18 (1848) 345.

Argentina sphyraena LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 366.

Clupea macrocephala LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 426, 428, 460.

Butirinus glossodontus RÜPPELL, Neue Wirbelthiere, Fische (1835–1840) 80; TEMMINCK and SCHLEGEL, Fauna Japon. Poiss. (1842) 242, GÜNTHER, Fish. Zanzibar (1866) 120.

Conorhynchus glossodon BLEEKER, Atl. Ichth. 6 (1866–1872) 83; Versl. Akad. Ams. 2 II, pt. 2 (1868) 300.

Albula conorhynchus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1848) 356; GÜNTHER, Cat. Brit. Mus. 7 (1868) 468; DAY, Fishes of India 4°. (1878–1888) 648; STREETS, Bull. U. S. Nat. Mus. 7 (1877) 76; SCHMELTZ, Cat. Mus. Godeffroy 6 (1877) 18; GÜNTHER, Rept. Voyage "Challenger" 1 (1880) 66; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 593; 8 (1883) 278.

Albula neoguinaica CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 253.

Albula seminuda CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 254.

Albula erythrocheilus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 254; CANTOR, Journ. Asiat. Soc. Bengal. 18 (1850) 283.

Albula forsteri CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 256.

Albula bananus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 249; BLEEKER, Ichth. Madura, Verh. Bat. Gen. 22 (1849) 11; KNER, Fische Novara Exp. (1865–1867) 339.

Albula glossodonta KLUNZINGER, Fische Rothen Meeres, Verh. z. b. Ges. Wien (1871) 602; STEINDACHNER, Denk. Akad. Wiss., Wien 70 (1901) 513.

Albula vulpes SEALE, Occ. Papers, B. P. Bishop Mus. 1 No. 2 (1902) 15, 18; JENKINS, Bull. U. S. Fish. Com. 22 (1902) 432; SNYDER, Bull. U. S. Fish Comm. 22 (1902) 521; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 pt. 1 (1903) 55; SEALE, Occ. Papers B. P. Bishop Mus. 4 No. 1 (1906) 5; KENDALL and GOLDSBOROUGH, Mem. Mus. Comp. Zool. 26 (1911) 242; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 7; MCCULLOCH, Rec. Austr. Mus. (1919) 172; FOWLER, Bull. B. P. Bishop Mus. 22 (1925) 4, 23; FOWLER and BALL, Bull. B. P. Bishop Mus. 26 (1925) 5; FOWLER, Bull. B. P. Bishop Mus. 38 (1927) 5; Mem. B. P. Bishop Mus. 10 (1928) 27; SCHMIDT, Pan-Pacific Res. Inst. 5 No. 4 (1930) 2.

Albula glossodon GÜNTHER, Fische der Südsee 3 (1909) 385.

Albula virgata JORDAN and JORDAN, Mem. Carnegie Mus. 10 (1922) 6.

Head 3.4–3.7; depth 4.3–4.6; dorsal 17; anal 7; scales 66–71 along lateral line, 6–7 behind caudal base; 17–18 on transverse series below origin of dorsal, 9 above lateral line, 25–27 predorsals.

Body elongate, slightly compressed, sometimes subcylindrical. Dorsal profile more convex than ventral, latter sometimes nearly straight. Caudal peduncle slightly compressed, length about equal to its least width, 4 in head. Head conical, terminating acutely. Snout prominent, heavy, long, 2.5 in head, broad behind, narrow anteriorly, greatest breadth 1.2 in its length. Maxillary barely reaches front margin of eye, slightly less than length of snout, superior portion hidden below preopercle, inferior portion thick with adipose tissue, exposed. Lower jaw pointed, not prominent, shorter than upper jaw, wedged between maxillaries. Villiform teeth on jaws, vomer, and palatines; strong, granular teeth on tongue, pterygoids, and sphenoid; the toothed portion of tongue elevated, wedged between protruding pterygoids and depressed sphenoid. Eye 5.4 in head, with thick adipose eyelid. Top of head wide, flat, straight, descending, covered with thick adipose membrane; tuberculate at posterior portion. Interorbital wide, 1.3 times orbit. Radiating venules on preopercle originating from posterior margin of eye. Cheek and preorbital with fine tubercles. Inferior margin of cheek immediately behind maxillary, lined with 7 to 9 subcircular scales, which are firmly attached to each other, smaller than body scales, with a central focus; anterior margin indented with two radii; anterior portion tuberculate. An occipital collar of thin, soft, scales, those on extreme lateral sides partly overlapping edge of opercular opening. Gill rakers 8 to 9, reduced to knob-shaped structure; gill filaments about 1.4 in head. Pseudobranchiæ about 40. Branchiostegals 13. Scales

adherent, regularly arranged, rather small, unimbricated portion silvery, with thin, wide, flabby, crenulate membrane bordering on smoothly convex hind margin; anterior margin more or less straight, with 4 to 6 prominent indentations, 2 to 4 radii arising from focus; posterior portion with horizontal rows of minute, pearly tubercles which lose linear arrangement toward focus. Scales on lateral line with convexity of posterior margin disturbed by the single lateral line tube. Lateral line nearly straight.

Dorsal origin about midway between snout tip and caudal base; base slightly shorter than height, which equals head minus snout; rays with a flap of scales each, which overlaps succeeding ray behind, partly imbricating next scaly flap. Anal small, base shorter than height, slightly longer than orbit. Pectorals well developed, about equal base of dorsal, extend slightly in front of origin of dorsal. Ventrals equal snout, with well-developed superior and inferior axillary scales. Membranes between rays of pectorals, ventrals, and anal with small, silvery scales.

Brilliant silvery all over. Dorsal portion of head light brown. A brownish black spot in front of nostril; a transverse band of similar color before tip of snout.

This description is based on No. 16219, 285 mm, collected from Cadiz Nuevo, Occidental Negros, August, 1929.

The only other specimen of the species in the collection (No. 16002), was obtained by S. T. Trawler "Los Pescados" from Mekong River, Tibet, in southern Asia.

CHANIDÆ

Body oblong, somewhat compressed, head depressed. Scales cycloid, small, adherent, longitudinally striped. Mouth terminal, small, and bordered above only by the intermaxillaries. Maxillaries without supplemental bone. Mandibles with a symphysial tubercle which fits into a notch between the intermaxillaries. Teeth absent. Dorsal opposite ventrals, which are longer than anal. Ventrals well developed, with 11 or 12 rays. Caudal forked. Gill membranes totally united, free from isthmus; 4 branchiostegals; pseudobranchiæ well developed; gill rakers in two diverging rows, very fine and numerous.

This family is represented by *Chanos chanos* Forskål, the only species in the Philippines.

CHANOS CHANOS (Forskål). Bañgos. Plate 1, fig. 3.

Mugil chanos FORSKÅL, Descript. anim. (1775) 14, 74.

Mugil salmoneus (Forster) (SCHNEIDER, Bloch, Syst. Ichth. (1801) 421; LICHTENSTEIN, Forster Descript. anim. (1884) 299.

Chanos cyprinella EYDOUX and SOULEYET, Voy. "Bonite" Zool. 1 (1841) 196.

Chanos oriental EYDOUX and SOULEYET, Voy. "Bonite" 1 (1841) 196.

Chanos salmoneus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 146; BLEEKER, Arch. Neerl. Sci. Nat. 13 (1878) 38; GÜNTHER, Rep. Voyage "Challenger" 1 (1880) 61; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 594; VAILLANT, Bull. Soc. Philom. Paris VII 11 (1886-87) 53.

Chanos chloropterus KNER, Novara Exp. Fische 1 pt. 5 (1865) 341.

Chanos orientalis SCHMELTZ, Cat. Godeffroy Mus. 4 (1869) 25.

Chanos chanos STEINDACHNER, Denk. Akad. Wiss., Wien. 70 (1901) 514; JENKINS, Bull. U. S. Fish Comm. 22 1902 (1903) 432; JORDAN and SCHNEIDER, Proc. U. S. Nat. Mus. 28 (1904) 124; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23 pt. 1, 1903 (1905) 56; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 (1905) 186; 26 (1906) 4; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236; EVERMANN and SEALE, Proc. U. S. Nat. Mus. 31 (1907) 505; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239; GÜNTHER, Journ. Godeffroy Mus. 8 pt. 16 (1909) 387; KENDALL and GOLDSBOROUGH, Mem. Mus. Comp. Zool. 26 (1911) 243; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 15; CHAUDHURI, Mem. Indian Mus. 5 (1916) 417; FOWLER, Bull. B. P. Bishop Mus. 22 (1925) 23; 38 (1927) 5; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; SCHMIDT, Pan-Pacific Res. Inst. 5 No. 4 (1930) 3.

Head 3.8–4; depth 3.4–3.8; dorsal 12–13; anal 8; scales 76–82 in median lateral line series; 32–36 in transverse series; 31–34 predorsals.

Body moderately elongated and compressed; dorsal profile slightly more convex than ventral which is rounded, broadened, especially on thoracic portion. Caudal peduncle rather long, about 2.3 in head, greater than least depth. Head width greater than twice length. Snout width greater than its length, equals eye diameter, undershot to a conical point. Eye large, twice nearer to snout tip than to posterior margin of operculum, 3.2 to 3.5 in head, with thick adipose eyelid. Mouth small; maxillary barely reaching front margin of eye, partly hidden below preorbital, toothless. Lower jaw slightly shorter than upper jaw, tightly wedged between rami of maxillary. Vertex low, concave, broad, greater than greatest diameter of eye, less than 3 in head; often covered with a thick adipose membrane. Nape

high, greatly convex, broad. Gill membranes completely united below. Branchiostegals 4, cemented together. Gill rakers 240 to 252, lanceolate, slender, smooth, short, one-third of gill filament, which is longer than half orbit. Scales regularly imbricated, strongly adherent, small, with length slightly greater than width; basal margin with a deep, cuneiform notch at middle portion; 25 to 39 longitudinal striæ on unimbricated portion, which terminate at posterior margin where each forms the pinnacle of serrature; focus central, distinct; circuli fine, circularity disturbed by basal notch to which they conform; discontinuous due to posterior striæ; no transverse striations. Lateral line straight except for anterior part which rises to summit of operculum.

Dorsal origin equidistant from front margin of orbit and caudal base; base sheltered in flaps of two rows of alar scales, 1.5 in length of longest ray which is 3 in distance of dorsal origin to snout tip, last ray much branched, ultimate branch longest. Caudal deeply forked, lobes much longer than head; directed slightly upward. Pectorals 1.5 in head; first ray large, strong, origin overlapped by margin of gill membrane. Ventrals well developed, slightly smaller than pectoral, equal dorsal base, 1.8 in head; origin nearer pectorals than caudal, base about below middle of dorsal; axillary scale well developed, tapers posteriorly, 1.7 in ventrals. Anal short, base less than height, about a snout length, somewhat protracted; rays, for a large part, enveloped in scaly sheaths.

Description based on Nos. 307 (261 mm) and 639 (307 mm) from Manila market, June 17 and August 4, 1927, respectively.

LUZON, Pampanga Province, Macabebe, No. 15414, 125 mm, May 6, 1927; Macabebe, No. 21155, 168 mm, May 6, 1927; Rizal Province, Malabon, Dampalet, Nos. 15264, 21158–62, 34–38 mm, May 8, 1927; Malabon, Tonsuya, No. 15245, 161 mm, March 30, 1927; Malabon, Nos. 21165–70, 43–55 mm, April 17, 1928; Manila, Manila market, No. 55393, 298 mm, July 8, 1927; Manila market, No. 951, September, 1907: Cavite Province, Cavite, Nos. 26993–97, 49–65 mm, September 27, 1927. PANAY, Iloilo Province, Dumangas, Nos. 15485, 21154, 176 and 218 mm, August 3, 1927; Jaro, No. 45481, 124 mm, August 14, 1927. BANTAYAN, Cebu Province, No. 5922–23, 111–125 mm, May, 1909. MACTAN, Cebu Province, Opon, No. 15443, 169 mm, August 27, 1927. BOHOL, Bohol Province, Kagtong, No. 14804, 143 mm, November 25, 1926. PALAWAN, Palawan Province, Panacan, Paragua,

Nos. 5311, 21164, 226 mm, August 14, 1908. BUNGAU, Sulu Province, Bungau, Nos. 21156–57, 10779, 59–80 mm, September 7, 1923.

CHIROCENTRIDÆ

Body very long and compressed. Scales thin, small, and very deciduous. Abdomen with sharp margin but without scutes. Mouth large, very oblique, bordered by large intermaxillaries and long narrow maxillaries with two supplemental bones. Mandibulars very prominent, teeth on mandibulars and median portion of intermaxillaries caninoid; those in other parts of the jaws are long and pointed, few teeth on palatines and tongue. Eyes small, subcutaneous. Dorsal above anterior part of very long anal. Ventrals very small, midway between caudal base and tip of snout. Pectorals situated low, folding like ventrals. Gill membranes separate, free; branchiostegals 8; gill rakers very short, strong, flattened, 13; no pseudobranchiæ.

This family is represented in the Philippines by one genus.

Genus CHIROCENTRUS Cuvier

The characters of the genus are the same as those of the family. One Philippine species is known.

CHIROCENTRUS DORAB (Forskål). Parang-parang. Plate 1, fig. 9.

Clupea dorab FORSKÅL, Descript. anim. (1775) 72; CUVIER and VALENCIENNES, Hist. Nat. Poiss. 19 (1846) 110; JOUAN, Mem. Soc. Cherbourg 18 (1861) 306; 21 (1877–78) 335.

Chirocentrus dorab BLEEKER, Atl. Ichth. 6 (1866–72) 92, 271; BLEEKER, Versl. Akad. Amsterdam 2 ser. II (1868) 300; PETERS, Monatsb. Akad. Wiss. Berlin 1876 (1877) 846; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 594; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 4; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 53; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236; GÜNTHER, Journ. Godeffroy Mus. 8 pt. 16 (1909) 388; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 18; FOWLER, Copeia No. 58 (June, 1918) 62; FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1922) 2; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256.

Head 5.7; depth 6; dorsal 16; anal 30. Body very elongate, strongly compressed; depth almost uniform from insertion of pectorals to anal; ventral profile sharp, nonserrate, with hairlike appendages in a single row from pectorals to anal. Caudal peduncle long, deep, length slightly greater than least depth, 2 in head measured from tip of lower jaw. Head small, well compressed, width 3.6 in its length, directed dorsally and anteriorly

so that the tip of snout rises above level of dorsal profile; shallow notch at junction of nape and vertex. Mouth large, oblique; lower jaw well protracted, longer than upper jaw. Maxillary reaches to below middle of eye; upper lip fold produced anteriorly into a small mesial flap which ends acutely and finds support on a pair of horizontal, sharp canines on the small premaxillary. Entire margin of maxillary armed with small, firm, sharp, teeth which become smaller and closely set towards posterior edge. Six to nine pairs of canine teeth on mandible, compressed, sharp, directed posteriorly, slightly upward. Tips of maxillary and mandible do not meet, leaving mouth slightly gaping and leaving first three to five pairs of mandibular canines and the single pair of maxillary canines exposed. Snout greater than orbit, less than four times head with lower jaw. Teeth on palatine, pterygoid, and tongue. Eye slightly advanced. Interorbital flat, about one orbit. Cheek, preopercle, and postorbital with extensive venation. Gill opening wide. Branchiostegals small, well hidden inside rami of mandible. Gill rakers 14, short, flat, blunt, toothed on inside edge, widely spaced, shingled flat on arch, about half filament which is shorter than orbit. Scales small, very deciduous, entire, regular, with fine circuli, without transverse striations. Dorsal low, situated far back, about 2.5 nearer to caudal base than to snout tip; slightly in front of anal which is long, more than twice dorsal base. Pectorals well developed, 1.4 in head, less than twice anal base; first ray strong, stout, compressed, with flat sides at right angle with body; ventral and dorsal axillary scales well developed. Dorsal 1.5 in pectorals. Ventrals much reduced, less than orbit; 1.6 nearer to anal origin than to pectorals; axillary dorsal scale longer.

The above description is based on No. 11597, 406 mm, obtained from Manila, December 23, 1924.

LUZON, La Union Province, Rabon, Rosario, Nos. 12482, 14334, 190 and 341 mm, July 27, 1925: Pangasinan Province, San Fabian, No. 4180, 354 mm, 1904: Manila, Manila market, No. 559, 295 mm, July, 1907; No. 11674, 282 mm, February 23, 1925: Camarines Sur Province, San Miguel Bay, No. 9524, 352 mm, December 19, 1918; Caiabanga, Nos. 11578, 13219, 21174–5, 237–277 mm, January 16, 1926; San Miguel, Nos. 21176–7, 166–257 mm, December 19, 1918. TABLAS, Romblon Province, Tablas, Nos. 10149, 21173 and 162, 174 mm, January, 1923. SAMAR, Samar Province, Buguey, No. 14796, 322 mm, December

6, 1926. PANAY, Iloilo Province, Dumangas, No. 10118, 239 mm, June 2, 1922; Estancia, No. 10439, 248 mm, June 2, 1922; No. 10859, 246 mm, July, 1922; No. 11765, 202 mm, February 11, 1925: Antique Province, Culasi, No. 41121, 66 mm, December 15, 1933. GUIMARAS, Iloilo Province, West Coast Guimaras Island, Nos. 41332, 41334, 113 and 125 mm, December 18, 1933. LEYTE, Leyte Province, Tacloban, No. 1187, 372 mm, September 4, 1907; Carigara, No. 7892, 253 mm, December 13, 1913. BANTAYAN, Cebu Province, Bantayan, No. 5559, 512 mm, April, 1909. MINDANAO, Davao Province, Davao, No. 3228, 148 mm, April 21, 1908. BASILAN, Sulu Province, Basilan, No. 10781, 339 mm, August, 1923.

We have the following foreign examples: Hongkong, No. 6245, 189 mm; No. 6258, 134 mm; No. 6265, 149 mm, August, 1910.

DUSSUMIERIIDÆ

More or less elongate fishes with rounded belly. Scales moderate or large, thin, deciduous. Abdominal scutes absent. Head more or less pointed. Mouth small, terminal bordered by the small intermaxillary and the long maxillary which has two supplemental bones. Jaws equal or nearly so. Teeth small, on jaws, vomer, palatines, pterygoids, and tongue, deciduous and may be wanting. Dorsal longer than anal, inserted opposite ventral. Gill membranes separate, free from isthmus; 6 to 15 branchiostegals. Gill rakers few, very fine, slender. Pseudobranchiæ present.

Key to the Philippine genera of the Dussumieriidæ.

a^1. Origin of dorsal nearer snout tip than caudal base; anal with 9 to 13 rays; branchiostegals 6..... *Spratelloides.*

a^2. Origin of dorsal nearer caudal base than snout tip; anal with 15 to 17 rays; branchiostegals 15 to 20..... *Dussumieria.*

Genus SPRATELLOIDES Bleeker

Body small, elongate, nearly subcylindrical. Tail short, scales large, thin, deciduous. Snout conical, jaws equal, cleft of mouth small. Dorsal short, its origin nearer end of snout than caudal base. Branchiostegals flat, 6; pseudobranchiæ well developed; gill rakers rather long.

Key to the Philippine species of Spratelloides.

a^1. Scales 35 or 36 in median lateral series; anal 9.
S. delicatulus (Bennett).

a^2. Scales 45 in median lateral series; anal 13..... *S. gracilis* (Schlegel).

SPRATELLOIDES DELICATULUS (Bennett).

Clupea delicatula BENNETT, Proc. Comm. Zool. Soc. 1 (1831) 168.
Clupea macassariensis BLEEKER, Journ. Ind. Arch. 3 (1849) 72.
Clupeoides macassariensis BLEEKER, Verh. Bat. Gen. 24 (1852) 17.
Spratelloides delicatulus GÜNTHER, Cat. Brit. Mus. 7 (1868) 464; BLEEKER, Atl. Ichth. 6 (1866–1872) 96; SCHMELTZ, Cat. Mus. Godeffroy 5 (1874) 37; GÜNTHER, Fische der Südsee 3 (1909–1910) 383.
Stolephorus delicatulus JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 (1906) 186; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 53; SEALE, Occ. Papers B. P. Bishop Mus. 4 No. 1 (1906) 5; KENDALL and GOLDSBOROUGH, Mem. Mus. Comp. Zool. 25 (1911) 243; FOWLER, Occ. Papers B. P. Bishop Mus. 8 No. 7 (1923) 375; Bull. B. P. Bishop Mus. 22 (1925) 4; FOWLER and BALL, Bull. B. P. Bishop Mus. 26 (1925) 5; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 256; Mem. B. P. Bishop Mus. 10 (1928) 29.

Head 4–4.4; depth 5.3–6; dorsal 11–12; anal 9–10; scales 35–37 on median lateral series, 7–8 on transverse series; predorsals 12–14.

Body elongate, moderately compressed; dorsal and ventral sides rounded. Snout conical, longer than eye which is about 4 in head. Maxillary reaches to front margin of eye. Interorbital less than eye, flat, nonvenulose. Prominent venules on cheek, preopercle, and opercle; characteristic black venules on preorbital just behind superior margin of maxillary. Gill rakers 22 to 26, finely lanceolate, slightly longer than gill filaments, shorter than eye. Scales deciduous, with 3 to 7 transverse striæ, all continuous, regular, posterior margin sometimes slightly and irregularly serrate. Dorsal origin nearer snout tip than caudal base; base depressed, much shorter than height, which equals head minus snout. Anal low, short, inserted about midway between caudal base and ventral origin. Pectorals slightly longer than postocular part of head, not reaching ventral, which is longer than eye and inserted below middle of dorsal, midway between pectorals and anal.

The above description is based on the 2 largest of 25 specimens bearing No. 2975, ranging in size from 31 to 53 mm, collected from Bacon, Sorsogon, 1904.

Genus DUSSUMIERIA Cuvier and Valenciennes

Body rather elongate, more or less compressed; abdomen rounded, not serrate. Scales of moderate size, deciduous; no lateral line. Snout pointed; upper jaw not projecting; cleft of mouth of moderate width. Form of mouth like that of *Clupea*. Jaws with small, fixed, nondeciduous teeth; patches of villiform

teeth on palatine, pterygoid, and tongue, but absent from vomer. Dorsal fin opposite ventral; anal moderate in length. Gill membrane with numerous very fine branchiostegals; pseudobranchiæ well developed.

Key to the Philippine species of Dussumieria.

a^1. Scales 40 to 42 in median lateral series.
D. acuta Cuvier and Valenciennes.

a^2. Scales 52 to 56 in median lateral series..... *D. hasseltii* (Bleeker).

DUSSUMIERIA ACUTA Cuvier and Valenciennes. Tulis. Plate 1, fig. 5.

Dussumieria acuta CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 343; CANTOR, Journ. Asiat. Soc. Bengal 18 (1850) 1268; KNER, Fische Novara Exp. (1865–1867) 330; GÜNTHER, Cat. Brit. Mus. 7 (1868) 466; DAY, Fish. Malabar (1865) 226; BLEEKER, Atl. Ichth. 6 (1866–1872) 647; MACLEAY, Proc. Linn. Soc. N. S. W. 8 (1883) 278; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 21; FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 art. 2 (1923) 2; FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 30; DERANIYAGALA, Spolia Zeylanica 15 (1929) 33; Ceylon Journ. Sci. 5 (1833) 82.

Dussumieria elopsoides BLEEKER, Ichth. Madura, Verh. Bat. Gen. 22 (1849) 12; Versl. Akad. Ams. 2 ser. II (1868) 300; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 5; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Dorsal 19–22; anal 14–17; pectoral 14–15; ventral 8; scales in median lateral series 40–42; scales in transverse series 11–12; head 3.5–3.8; depth 4.1–4.6; predorsal scales 18–19; pre- and postventral scutes indistinct.

Body elongate, moderately compressed, fusiform, dorsal and ventral profile evenly convex; symphysis to ventral fin evenly convex, dorsal profile of head with vertex straight. Caudal peduncle moderately compressed, least depth 1.5 to 3 in its length. Head width 1.6 in its length; snout width 1.2 in its length, 2.3 to 3 in head. Eyes 3.6 in head. Lower jaw longer and more prominent than upper. Maxillary 2.3 in head not reaching below front margin of eye. Teeth on jaws, tongue and palate, but not on vomer. Interorbital flat, slightly concave, with a ridge at middle, 4.3 in head; no venation on vertex. Cheek without large prominent striæ; no venation on post-, pre-, and subopercle. Gill rakers 22 to 24, finely lanceolate, with very fine spines along inner side, about 2 in eye, practically equal to branchial filaments in length. Scales thin, deciduous, their hind margin indistinctly crenulate. Elongated scales on axil of pectorals and ventrals. Scales with 9 striæ, all broken; circuli fine, parallel.

Dorsal depressible in scaly sheaths, its origin much nearer to caudal than to tip of snout, its branched ray 2 to 2.5 in head. Caudal deeply forked. Pectoral depressible in basal scaly flaps, 1.5 in head; ventral 2 in pectoral; axillary ventral scale from 2.3 to 2.5 in pectoral. Ventral inserted beneath last half of dorsal; ventral 2.5 to 3 in head. Origin of anal far behind dorsal, about as long as postorbital part of head, shorter than ventrals; ultimate anal ray well developed.

This description is based on No. 89, 83 mm, and No. 6862, 130 mm, from Manila market, June 10, 1910.

LUZON, Bataan Province, Orani, No. 23967, 52 mm, April 29, 1923; Manila, Manila market, No. 61, 118 mm, May 25, 1907; Nos. 89–91, 82–108 mm, May 31, 1907; No. 159, 110 mm, June 7, 1907; Nos. 6858–59, 117 mm, June, 1910; Nos. 6860–68, 85–130 mm, June, 1910; No. 21241, 65 mm, June, 1910.

DUSSUMIERIA HASSELTII Bleeker. Tulis. Plate 1, fig. 2.

Dussumieria hasseltii BLEEKER, Nat. Tijdschr. Ned. Ind. 1 (1851) 422; Verh. Bat. Gen. 24 (1852) 13; Atl. Ichth. 6 (1866–1872) 95; DAY, Fishes of India 4°. (1878–1888) 647; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 23; FOWLER, Copeia No. 58 (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 256.

Dussumieria elopsoides GÜNTHER, Cat. Brit. Mus. 7 (1868) 466 (nec Bleeker); JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Dorsal 18–20; anal 16; pectoral 14–15; ventral 8; scales 52–56 in median lateral series; 12–13 in transverse series; head 3.3 3.6; depth 4.1–4.5; predorsal scales 18–21; pre- and postventral scutes indistinct.

Body elongate, more or less compressed, fusiform; dorsal and ventral profile evenly convex; symphysis to ventral fin convex. Caudal peduncle moderately compressed, its least depth 1.5 in its length; 3 in head. Head width 1.5 in its length; snout width equal length, about 3 in head. Eye about 3.5 to 4 in head. Lower jaw longer and more prominent than upper. Maxillary nearly reaching below front margin of eye, 2.3 to 2.5 in head; teeth on jaw, palatines, pterygoids, and tongue. Interorbital flat, slightly concave with a ridge at middle, 4.5 in head, vertex without venation. Cheek without large prominent striæ, and no venation on post-, pre-, and subopercle. Gill rakers 22 to 24, finely lanceolate, with very fine spines along inner side, about 2.1 in eye, slightly longer than branchial filaments; pseudo-

branchiæ 19. Scales thin, deciduous, crenulate, and entire, with 11 to 15 striæ, 2 to 8 unbroken; circuli fine, elongate scales at axil of pectorals and ventrals. Origin of dorsal more than eye diameter nearer caudal than snout. Dorsal depressible in basal scaly sheaths, the first branched ray 3 in head. Caudal deeply forked. Pectoral depressible in basal scaly flaps, 1.6 to 2 in head; ventral 2; axillary ventral scale 2 to 2.3. Origin of ventral below middle of dorsal, 1.4 in head. Origin of anal far behind dorsal as long as postorbital part of head, shorter than ventral; ultimate ray well developed.

The above description is based on No. 21262, 117 mm, obtained from Barrio Sibubu, Camarines Sur, January 17, 1926.

LUZON, La Union Province, Rosario, Barrio Rabon, No. 12456, 84 mm, July 25, 1925; Tayabas Province, Unisan, Nos. 14850, 21216–17, 75–78 mm, February 15, 1924: Camarines Sur Province, San Miguel Bay, No. 11687, 122 mm, November 11, 1924; Nos. 21225–29, 93–103 mm, July 11, 1924; Barrio Sibubu, Nos. 13241, 21260–64, 112–122 mm, January 17, 1926. SAMAR, Samar Province, San Pedro Bay, near Basey, Nos. 12364, 21230–34, 111–114 mm, September 17, 1925. PANAY, Antique Province, Culasi, Nos. 41117, 41309–10, 88–109 mm, December 15, 1933. GUIMARAS, Iloilo Province, west side of Guimaras Island, Nos. 41312–13, 43–74 mm, December 10, 1934.

DOROSOMIDÆ

Body short, deep, strongly compressed. Scales thin, more or less adherent. Abdominal scutes keeled, spiny. Snout conical, prominent, mouth small, inferior, bordered by intermaxillaries only; maxillaries narrow, with one supplemental bone; no teeth. Eye with adipose eyelid. Dorsal opposite ventrals; anal rather long; pectorals and ventrals moderate; caudal forked. Gill membranes separate, free; branchiostegals 5 to 6; gill rakers short, slender, numerous; pseudobranchiæ large.

Key to the Philippine genera of the Dorosomidæ.

a^1. Edge of dentary not reflected at angle of mouth, before end of maxillary; hindmost dorsal ray produced into a filament..... *Clupanodon.*

a^2. Edge of dentary reflected outward at angle of mouth, before end of maxillary.

b^1. Last dorsal ray prolonged into a filament; maxillary slightly expanded terminally and curved downward..... *Nematalosa.*

b^2. Last dorsal ray not prolonged into a filament; maxillary a straight, thin, transversely expanded plate, tapering..... *Anodontostoma.*

Genus NEMATALOSA Regan

Mouth toothless, subterminal or inferior, transverse, its cleft forming an angle; dentary edge reflected outwards in front of end of maxillary; one supplemental maxillary bone present; scales 44 to 50 in median lateral series, 14 to 21 in transverse series; dorsal rays 13 to 18; anal 18 to 24; ventral with 8 rays, below or little before dorsal.

There is one Philippine species of this genus.

NEMATALOSA NASUS (Bloch). Suagan. Plate 1, fig. 1; Plate 3, fig. 2.

Clupea nasus BLOCH, Ausl. Fische 9 (1795) 116.

Chatoessus nasus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 21 (1848) 76; BLEEKER, Verh. Bat. Gen. 24 (1852) 50; GÜNTHER, Cat. Brit. Mus. 7 (1868) 407; DAY, Fishes of India 4°. (1866–72) 142; RAMSAY and OGILBY, Proc. Linn. Soc. N. S. W. 1 (1886) 8.

Chatoessus selangkat KNER, Novara Exp. Fische (1865–67) 337 (nec Bleeker).

Dorosoma nasus BLEEKER, Atl. Ichth. 6 (1866–72) 142; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 24; DERANIYAGALA, Spolia Zeylanica 15 (1929) 45.

Konosirus thrissa JORDAN and SEALE, Proc. Davenport Acad. Sci. 10 (1905) 2 (not *Clupea thrissa* Linnæus); EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 54; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Konosirus nasus JORDAN and HERRE, Proc. U. S. Nat. Mus. 31 (1906) 625; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.

Clupanodon thrissa FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 32.

Nematalosa nasus HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 4–4.2; depth 2.2–2.3; dorsal 15–17; anal 21–23; scales 40–45 in median lateral series; 18–19 in transverse series; 18 predorsals; abdominal scutes, 18 preventral, 11–12 postventrals.

Body oblong, deep, strongly compressed; belly cultrate, lined by spinous and firm scutes which become less trenchant anteriorly. Profiles greatly convex, dorsal uniform; ventral acute from pectorals to anal. Head small, width about 1.7 its length; snout shorter than eye which is 3.3 to 3.5 in head. Maxillary slender, expanded terminally and curved downward, its greater portion hidden beneath preorbital and premaxillary; reaches to below middle of pupil. Interorbital wide, equals eye; tuberculate, slightly convex; with a slightly prominent keel; margin of vertex finely serrate; venules on cheek and preopercle. Gill rakers 135 to 139; very finely lanceolate, smooth, 1.4 in gill filaments, about 3 in head. Pseudobranchiæ prominent, 22 to 25. Scales adherent, wider than long; with one characteristic transverse continuous stria, which may be wavy; posterior margin serrate with indistinct crenulations; basal margin smooth.

Dorsal origin nearer snout than caudal base; base submerged in scaly sheaths, less than height, last ray in adult prolonged along dorsal margin reaching to caudal base; fragile, setiform, about equal to body depth, about 3 times dorsal base; not prolonged, however, in specimens less than 100 mm long. Anal long, equals head without snout, about 2 in body depth; last ray reaches to first third caudal; height 2.5 in base. Pectorals high, about equal head; first ray strong, stout; reaches to about insertion of ventrals. Ventrals 1.6 in pectorals, slightly less than twice orbit, equidistant from pectorals and anal measured from origin to origin. Caudal 2.7 in body length. With a characteristic black spot on shoulder.

The above description is based on No. 4311, 154 mm, Zamboanga, June 3, 1908; No. 5347, 151 mm, and No. 5348, 145 mm, Panacan, Palawan, August 16, 1908.

This species is easily confused with *Clupanodon punctatus*, in having the last dorsal ray produced, and in having similar head and fins. Besides differing in the structure of the maxillary, the two species differ by the following characters: Depth of *Nematalosa nasus* about 2 or slightly more than 2; *C. punctatus*, 3 or more. Scales in longitudinal series, about 40 in *N. nasus*, about 50 in *C. punctatus;* transverse scales, 18–19 in *N. nasus*, 20–23 in *C. punctatus*. Scales similar in that both have the characteristic single uninterrupted transverse striæ; but the scales of *N. nasus* have the posterior edge serrate, in *C. punctatus* the edge is smooth, rarely serrate.

The above differentiation of the two species is made possible by the presence of two specimens of *C. punctatus*, Nos. 10388 and 23053, from Amoy, China.

LUZON, Pampanga Province, Macabebe, Pilipit, Nos. 15326, 23043, 86–88 mm, May 7, 1927: Zambales Province, Iba, No. 11957, 80 mm, October 26, 1921: Manila market, No. 410, 162 mm, June 27, 1907; Manila Bay, No. 41250, 150 mm, October 20, 1929: Rizal Province, Malabon, No. 713, 170 mm, July 18, 1907; Nos. 15300, 110 mm, April 30, 1927; No. 15305, 110 mm, March 31, 1927: Sorsogon Province, Bacon, No. 23052, 167 mm, 1904: Albay Province, Legaspi market, No. 11820, 180 mm, September 21, 1924. PANAY, Antique Province, San Jose, No. 13145, 57 mm, 1926; No. 23053, 50 mm, 1927: Iloilo Province, Dumangas, Nos. 15451, 23562, 71–60 mm, August 5, 1927; La Paz, No. 15455, 73 mm, August 6, 1927; Molo, No. 15468, 96 mm, August 5, 1927.

PALAWAN, Palawan Province, Panacan, Paragna, Nos. 5348, 150 mm, August 16, 1908; Barrio Guinlo, Malampaya Sound, Nos. 15640, 23048–49, 112–117 mm, April 26, 1927. MINDANAO, Zamboanga Province, Zamboanga, No. 4311, 150 mm, June 3, 1908.

Genus ANODONTOSTOMA Bleeker

Supplemental maxillary very slender; scales 40 to 42 in median lateral series, 12 to 17 in transverse series; dorsal rays 17 to 19 with broad basal scaly sheath extending to end of last ray; anal rays 18 to 21 and depressible in scaly sheath; ventral with 8 rays, below middle or front half of dorsal.

ANODONTOSTOMA CHACUNDA (Hamilton-Buchanan). Cabase. Plate 1, fig. 13; Plate 3, fig. 1.

Clupanodon chacunda HAMILTON-BUCHANAN, Fishes Ganges (1822) 246.

Gonostoma javanicum VAN HASSELT, Algemeene Konst en Letterbode (1823) 329.

Chatoessus chacunda CUVIER and VALENCIENNES, Hist. Nat. Poiss. 21 (1848) 81; CANTOR, Journ. Asiat. Soc. Bengal 18 (1850) 1293; BLEEKER, Verh. Bat. Gen. 24 (1852) 46; KNER, Fische Novara Exp. (1865–1867) 337; GÜNTHER, Cat. Brit. Mus. 7 (1868) 411; DAY, Fishes of India 4°. (1878–1888) 632.

Anodontostoma hasseltii BLEEKER, Verh. Bat. Gen. 22 (1849) 15; FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 32.

Chatoessus selangkat BLEEKER, Verh. Bat. Gen. 24 (1852) 47.

Dorosoma chacunda BLEEKER, Atl. Ichth. 6 (1866–1872) 143; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 25.

Dorosoma indicus CHAUDHURI Mem. Indian Mus. 5 (1916) 419.

Anodontostoma chacunda FOWLER, Hongkong Nat. 2 (1931) 79; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.5–3.8; depth 2.0–2.2; dorsal 18–19; anal 18–19; scales 35–38 in longitudinal series; 13–14 in transverse series; 13–15 predorsals; abdominal scutes, 16–17 preventrals, 10–12 postventrals.

Body oblong, strongly compressed, deep. Profiles greatly convex; belly less trenchant anteriorly, with spiny scutes. Head small, width 1.8 to 1.9 in its length; snout heavy, shorter than eye which is 3.4 to 3.6 in head. Maxillary straight, thin, transversely expanded and tapering terminally; reaches to slightly past front margin of pupil. Interorbital about eye diameter, slightly convex, keeled at center, with thick adipose covering. Venations on cheeks. Gill rakers 74 to 78, fine, smooth, flattened, shorter than gill filaments. Pseudobranchiæ 16 to 18. Scales adherent, large, wider than long, with 4 to 7 transverse

striæ, 1 to 2 of which are usually continuous; posterior margin "ctenoid," with pseudospines; basal margin smooth.

Dorsal origin nearer to caudal base than to snout tip; last ray not produced, base longer than height, about head minus snout. Anal rather long, about 1.6 in head, 2.6 to 2.8 in body depth, equals length of operculum; last anal ray barely, if at all, reaching base of caudal, height 6.6 to 6.8 in base. Pectorals high, slightly less than head; first ray well developed, strong. Ventrals about preocular part of head, midway between pectorals and anal measured from origin to origin. Caudal 2.7 to 2.8 in body length. With a characteristic black spot, less than eye, on shoulder.

This species is easily differentiated from *N. nasus* by the absence of a prolonged setiform dorsal ray which is characteristic of the latter. This alone does not separate the two species of sizes below 100 mm as it is equally undeveloped in both. *A. chacunda*, however, has 13 to 14 scales in the transverse series, the scales are larger, with 6 to 8 transverse striæ, and there are less than 100 gill rakers.

The above description is based on No. 14795, 135 mm, No. 23050, 139 mm, and No. 23151, 133 mm, obtained from Basey, Samar, December 6, 1926.

LUZON, La Union Province, Rosario, Barrio Damortis, Nos. 14320, 23047, 99–94 mm, August 3, 1926; Barrio Rabon, No. 12453, 137 mm, August, 1926: Bataan Province, Orani, No. 11311, 114 mm, April 29, 1923: Rizal Province, Malabon, No. 714, 182 mm, June 18, 1907: Manila, Manila market, Nos. 13–15, 99–105 mm, May 21, 1907; No. 139, 113 mm, June 12, 1907; No. 312, 108 mm, June 17, 1907; No. 972, 100 mm, September, 1907: Camarines Sur Province, San Miguel Bay, Nos. 10433, 23043–46, 69–105 mm, January 3, 1919; Calabanga, Nos. 13243, 23033–36, 99–165 mm, January 16, 1926. MINDORO, Mindoro Province, Mangarin, Nos. 11032, 23041, 118–91 mm, 1913. MASBATE, Masbate Province, Guinobatan, No. 1061, 97 mm, August 30, 1902. LEYTE, Leyte Province, Tacloban, No. 1190, 124 mm, September 24, 1907; No. 9579, 134 mm, May 7, 1921; Carigara, No. 7888, 123 mm, December 11, 1913. SAMAR, Samar Province, Basey, Nos. 14795, 23050–51, 51–127 mm, December 2, 1926. PANAY, Iloilo Province, Estancia, Nos. 11654, 23031, 95–97 mm, February 11, 1925; Molo, No. 15468, 85 mm, August 5, 1927: Capiz Province, Capiz, Nos. 12749, 23032, 110 mm, July 30, 1925: Antique Province, Culasi, No. 41123, 89

mm, December 15, 1933. GUIMARAS, Iloilo Province, La Paz, No. 15455, 75 mm, August 6, 1927; Dumangas, Nos. 15451, 23562, 65 mm, August 5, 1927; West coast of Guimaras, No. 41321, 72 mm, December 18, 1934. BALABAC, Palawan Province, Balabac, Nos. 5059–5064, 172–174, August 5, 1908. MINDANAO, Davao Province, Davao, 3232, 3486, 125–184 mm, April 25, 1908: Agusan Province, Agusan River, No. 4236, 154 mm, 1904.

In the collection are the following extra-Philippine specimens: BORNEO, Sandakan, Nos. 2450, 2511, 2541, 2562–65, 2617, 2675, 71–104 mm, February, 1908; No. 14160, 106 mm, November 21, 1925.

ENGRAULIDÆ

Body oblong, elongate, more or less compressed, scales thin, deciduous; belly cultrate or slightly rounded with keeled abdominal scutes; snout prominent, mouth large, bordered by very small intermaxillaries which do not meet in symphysis, and by the long narrow maxillaries which may be prolonged. Teeth in jaws in one row, small, rarely caninoid; teeth present on vomer, palatines, pterygoid and tongue. Dorsal somewhat short, above or in front of anal; anal usually long. Gill membranes more or less united, free from isthmus; 7 to 19 branchiostegals, gill rakers long, slender; pseudobranchiæ present.

This family is usually divided into two subfamilies; namely, the Coiliinæ, in which the body is greatly elongate and the long anal fin unites with the caudal; and the Stolephorinæ, in which the body is not greatly elongate and the anal fin is shorter and not united with the greatly forked caudal. All Philippine members of the family belong to the latter. We have for comparison, however, a number of examples of the genus *Coilia* obtained from China.

Key to the Philippine genera of the Engraulidæ.

a^1. Maxillary greatly prolonged, extending to base of pectoral or beyond. *Thrissocles.*

a^2. Maxillary moderate, not extending to base of pectorals.

b^1. Body well or moderately compressed, without silvery, lateral stripe.

c^1. Ventral scutes strong, developed from gill opening to vent; anal rays about 40..... *Scutengraulis.*

c^2. Ventral scutes weak, almost hidden by the scales, only one or two in front of pectorals; anal rays 32..... *Thrissina.*

b^2. Body more or less subcylindrical, translucent, with a silvery lateral stripe; ventral margin with two to seven sharp scutes only between pectorals and ventrals; anal rays 15 to 37..... *Stolephorus.*

Genus THRISSOCLES Jordan and Evermann

Body shape and compression similar to *Scutengraulis;* maxillary excessively long, extending beyond base of pectorals, sometimes even up to anal; gill rakers 10 to 18; pectorals reach to ventrals; origin of anal below last rays of dorsal; no silvery lateral stripe.

One Philippine species.

THRISSOCLES SETIROSTRIS (Broussonet). Plate 1, fig. 6.

Clupea setirostris BROUSSONET, Ichth. 1 (1782).

Clupea mystacina FORSTER, Schneider Syst. Ichth., Bloch (1801) 482; LICHTENSTEIN, Forster Descript. anim. (1844) 295.

Engraulis setirostris CUVIER and VALENCIENNES, Hist. Nat. Poiss. 21 (1849) 69; GÜNTHER, Cat. Brit. Mus. 7 (1868) 397; BLEEKER, Atl. Ichth. 6 (1866–72) 134; DAY, Fishes of India 4°. (1878–1888) 626.

Thryssa macrognathus BLEEKER, Bijd. Ichth. Madura, Verh. Bat. Gen. 12 (1849) 14.

Stolephorus setirostris GÜNTHER, Cat. Brit. Mus. 7 (1868) 397.

Anchovia setirostris JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 237.

Engraulis setirostris GÜNTHER, Fische der Südsee 3 (1909–1910) 379; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258; Mem. B. P. Bishop Mus. 10 (1928) 32.

Thrissocles setirostris FOWLER, Hongkong Nat. 2 (1931) 202; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.7–3.9; depth 3.2–3.5; dorsal I, 10–13; anal 34–36; scales 39–42 in median lateral series; 10–11 in transverse series; 20–22 predorsals; abdominal scutes 27–28, 18 being postventral.

Body elongate, strongly compressed, dorsal and ventral profiles about equal, belly cultrate. Head blunt, snout prominent, short, much less than eye which is 3.5 to 3.7 in head. Maxillary produced to a long filament surpassing ventrals, often reaching anal, strongly expanded near mandibular joint. Jaws with a single row of minute teeth; maxillary prolonged, extending beyond ventrals, often to anal, toothed throughout its entire inferior margin. Dorsal surface of head laterally convex with a prominent median keel; interorbital slightly less than eye. Venules conspicuously wanting. Gill rakers 12, finely lanceolate, flattened, inner side spinulose, slightly longer than gill filaments, nearly equal eye. Scales deciduous, with 9 to 12 vertical striæ, some discontinuous with median terminals overreaching each other; margins smooth, nonfenestrate.

Dorsal origin slightly nearer caudal base than snout tip; base short, 2 in its height which is slightly longer than head without

snout. Anal long, 3 to 3.3, about twice height. Pectorals about height of dorsal, reaching past ventral insertion. Ventrals more than twice eye, midway between pectorals and anal; reaches to anal opening.

Black venules on shoulder; pale reddish spots superior and inferior to ventral and pectoral bases.

The above description is based on No. 977, 69 mm, obtained in a Manila market, July, 1907.

LUZON, Cagayan Province, Aparri, No. 10384, 117 mm, May 22, 1923: Rizal Province, Malabon, No. 10423, 117 mm, April 21, 1923: Manila, Nos. 63, 207, 208, 977, 110–111 mm, June 12, 1907. MINDORO, Mindoro Province, Calapan, No. 10357, 98 mm, January, 1923; Mangarin, Nos. 11552, 23875–78, 90 mm, 1913.

In the collection are the two following foreign specimens: No. 10345, 115 mm, from Amoy, China, 1923, and No. 10105, 70 mm, from Hoihao, Hainan, 1923, both collected by S. F. Light.

In addition, the following specimens of *Thrissocles dussumieri* (Bleeker) are in the collection: No. 6398, 82 mm, from Hongkong, August, 1910; Nos. 6248, 6253, 6261–62, all about 98 mm long, from Hongkong, 1910. In this species the maxillary does not extend beyond the ventrals.

Genus SCUTENGRAULIS Jordan and Seale

Body thin, deep, compressed, elongate. Scales more or less deciduous. Strong abdominal scutes always present between pectorals and anal, also in front of pectorals. Mouth oblique; maxillary usually produced, ending between mandibular joint and axil of pectoral, usually extending beyond gill-opening. Origin of dorsal ahead of that of anal which is usually rather long (27 to 50 rays). A tiny free spine in front of dorsal. Upper pectoral rays not produced. Teeth present on jaws, vomers palatines, pterygoid, and tongue. No caninoid teeth.

This genus is represented by two species in the Philippines. In addition several specimens of *Scutengraulis hammalensis*, Nos. 10369, 23890–96, all about 88 mm long, from Amoy, China, are in the collection.

Key to the Philippine species of Scutengraulis.

a^1. Maxillary reaches only to gill opening..... *S. hamiltonii* (Gray).
a^2. Maxillary nearly reaches root of pectoral..... *S. mystax* (Bloch).

SCUTENGRAULIS HAMILTONII (Gray). Dumpilas. Plate 1, fig. 10.

Thryssa hamiltonii GRAY, Illustr. Indian Zool. 2 (1830–35) Pisc. tab. 5, fig. 3 (fig. only).

Engraulis grayi BLEEKER, Verh. Bat. Gen. 24 (1852) 41; KNER, Fische Novara Exp. (1865–67) 333.

Engraulis hamiltonii GÜNTHER, Cat. Brit. Mus. 7 (1868) 395; DAY, Fishes of India 4°. (1878–1888) 625; VINCIGUERRA, Ann. Mus. Civ. Genova 2 (1885) 94; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258.

Stolephorus hamiltonii BLEEKER, Ned. Tijdschr. Dierk. 1 (1863) 261.

Engraulis poorawah BLEEKER, Atl. Ichth. 6 (1866–72) 132.

Trichosoma hamiltonii RUTTER, Proc. Acad. Nat. Sci. Phila. (1897) 66.

Anchovia hamiltonii JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1907) 236.

Engraulis grayi WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 37.

Scutengraulis hamiltonii JORDAN and SEALE, Bull. Mus. Comp. Zool. Harvard 67 (1926) 371.

Anchoviella hamiltonii DERANIYAGALA, Ceylon Journ. Sci. § C 5 (1933) 81.

Head 4.4; depth 3–3.4; dorsal I, 14; anal 40; scales 38–39 in median lateral series; 11–12 in transverse series, 15 predorsals; abdominal scutes, 16 preventrals, 10 postventrals, sharp and spiny, especially the postventrals.

Body oblong, deep, well compressed; ventral profile slightly more convex than dorsal. Snout shorter than eye, which is 4.3 in head. Maxillary produced, reaching gill opening; dilated at mandibular joint, from thence tapering posteriorly to a sharp point. Jaws about equal with a single row of minute sharp teeth. Dorsal part of head with a sharp median keel, convex, finely tuberculate; interorbital equal eye. Gill rakers 14, strongly flattened, with prominent spines on inner edge; about 1.4 longer than filaments, slightly less than orbit. Scales large, rather deciduous, with 7 to 15 transverse striæ, broken, irregularly arranged, those near posterior border anastomosing and reticulose; posterior margin irregularly serrate.

Dorsal origin nearer caudal than snout tip; base short, about 2 in its height which is about equal to head without snout. Anal long, 3.1 in body length, height 2.7 in its base. Pectoral nearly as long as height of dorsal, reaches to ventral origin, first ray large, strong. Ventral small, about 1.5 times eye, 2.7 in pectoral, nearer pectoral than anal, far in advance of dorsal origin.

With black venules on scapular region.

This description is based on No. 41286, 197 mm, collected by Mr. A. F. Umali from Divisoria market, March 13, 1931.

LUZON, Camarines Sur Province, Calanga, Nos. 13244, 23853–23863, 120–125 mm, January 16, 1926. LEYTE, Leyte Province, Tacloban, No. 1200, 170 mm, September 4, 1907.

In addition, we have 5 specimens, No. 10126, 113 mm, from Haichow, Hainan, China.

SCUTENGRAULIS MYSTAX (Bloch). Plate 1, fig. 8.

Clupea mystax BLOCH, Schneider Syst. Ichth. (1801) 426.

Thryssa porava BLEEKER, Verh. Bat. Gen. 22 (1849) 14.

Engraulis mystacoides BLEEKER, Verh. Bat. Gen. 24 (1852) 42; GÜNTHER, Cat. Brit. Mus. 7 (1868) 396.

Engraulis hamiltonii KNER, Fische Novara Exp. (1865–67) 334.

Engraulis mystax BLEEKER, Atl. Ichth. 6 (1868–72) 132; DAY, Fishes of India 4°. (1878–1888) 625; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 38; CHAUDHURI, Mem. Indian Mus. 5 (1916) 424.

Trichosoma porava RUTTER, Proc. Acad. Nat. Sci. Phila. (1897) 65.

Scutengraulis mystax JORDAN and SEALE, Bull. Mus. Comp. Zool. 67 (1926) 370.

Head 4.3–4.7; depth 3.3–3.5; dorsal I, 14; anal 40–42; scales 40–44 in median lateral series; 11–12 in transverse series; preventral scutes 17–19 (5 or 6 of which are prepectorals); postventrals 9–11.

Body oblong, well compressed, dorsal profile nearly straight; ventral profile well convexed. Mouth large; maxillary much elongate, tapering to a point, and nearly reaching base of pectorals. Snout short, slightly longer than half diameter of eye which is 4 in head; a single row of small teeth on each jaw. Teeth on pterygoid, vomer, palatine, and tongue. Upper surface of head with a median longitudinal crest which extends from snout to nape; tuberculate and with small melanophores along sides of crest. Interorbital equal to eye. Branchiostegals 11 to 13; gill rakers 13, compressed, rather firm, distinctly spinous. Scales large, adherent, with 4 to 8 transverse striæ, 2 to 4 continuous; hind margin serrated with narrow and regular crenulations.

Dorsal slightly nearer caudal than snout; base 1.6 in height which is more than twice body depth. Anal long, 2.7 to 3, inserted below posterior ray of dorsal; height twice caudal peduncle. Pectorals slightly longer than head without snout. Ventrals small, 2.5 in pectorals, greater than orbit; inserted

well in front of dorsal; much nearer pectorals than anal; pectorals extending past ventral origin.

Scapular region with melanophores in clusters arranged in rows; dark spots along dorsal margin from head to caudal.

The above description is based on Nos. 23951 and 23954, 100 mm and 112 mm, obtained from Cabusao, Camarines Sur.

LUZON, Camarines Sur Province, Cabusao, Nos. 11454, 23951–54, 78–100 mm, December 21, 1918; San Miguel Bay, Nos. 115687, 23976–82, 71–113 mm, September 27, 1924; No. 12039, 119 mm, February–March, 1922. SAMAR, Samar Province, Basey, No. 14721, 152 mm, December 6, 1926. PANAY, Iloilo Province, Barotoc, No. 15448, 90 mm, August 4, 1927. NEGROS, Negros Occidental Province, Cadiz, No. 16190, 132 mm, August, 1929.

One specimen, No. 14175, 78 mm, was collected from Sandakan, Borneo, November 21, 1925.

Genus THRISSINA Jordan and Seale

Scutes small, almost hidden by the scales, usually absent in front of pectorals. Body moderately compressed not very deep. Maxillary not extending posterior of root of mandible. Gill rakers about 23.

THRISSINA BÆLAMA (Forskål). Dumbilas. Plate 1, fig. 7.

Clupea baelama FORSKÅL, Descript. anim. (1775) 72; BLOCH, Schneider, Syst. Ichth. (1801) 429.

Engraulis bælama CUVIER and VALENCIENNES, Hist. Nat. Poiss. 21 (1848) 26; GÜNTHER, Cat. Brit. Mus. 7 (1868) 393; BLEEKER, Atl. Ichth. 6 (1866–72) 130; KLUNZINGER, Verh. z. b. Ges. Wien 21 (1871) 597; GÜNTHER, Proc. Zool. Soc. London (1871) 671; DAY, Fishes of India 4°. (1878–1888) 626; GÜNTHER, Fische der Sudsee 3 (1909–1910) 379.

Stolephorus encrasicholoides BLEEKER, Ned. Tijdschr. Dierk. 1 (1863) 236.

Engraulis encrasicholoides KNER, Fische Novara Exp. (1865–1867) 333; GÜNTHER, Cat. Brit. Mus. 7 (1868) 387; SCHMELTZ, Cat. Mus. Godeffroy (1869) 25; MACLEAY, Proc. Linn. Soc. N. S. W. 7 (1882) 593; 8 (1883) 278.

Anchovia baelama JORDAN and RICHARDSON, Bull. Bur. Fish. 27 (1907) 236; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.

Engraulis bælama WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 33; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258; Mem. B. P. Bishop. Mus. 10 (1928) 32.

Thrissina baelama JORDAN and SEALE, Bull. Mus. Comp. Zool. 67 (1926) 376; HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.5–3.7; depth 4–4.4; dorsal II, 13; anal 27–30; scales 34–36 in lateral median series; 9 in transverse series; 14 predorsals; 17 abdominal scutes, 8 preventrals.

Body only compressed, not very deep, dorsal and ventral profiles nearly equal in convexity, scutes pointed behind, weakly attached, none in front of pectorals except a single reduced one, just behind isthmus. Length of caudal peduncle about equal to its least depth, less than 3 in head. Snout large, length less than an orbit, about 4.5 in head. Mouth large, oblique; maxillary long but not extending beyond root of mandible; equals head minus snout, longer than ventrals, thick and narrow anteriorly, rather broad and flat posteriorly. Lower jaw short, small, extensible below ventral margin. Both jaws with a row of firm, minute, closely-set teeth. Teeth on vomer, tongue, pterygoid, and palatine. Eye well advanced, 3 times nearer snout than opercular opening. Interorbital convex, keeled on median longitudinal plane, striated and tuberculate. Posterior opercular edge oblique, dorsal portion well advanced. Cheeks veined, tuberculate. Branchiostegal rays 13 to 15. Gill rakers 19 to 23. lanceolate, compressed, spinulous on exposed edge, longer than filaments, slightly less than orbit. Pseudobranchiæ 20 to 22, short, unequal, base hidden in membranous flap. Scales rather adherent, large with 12 to 15 transverse striations. Posterior margin irregularly serrate, produced portion often with several small reticula.

Dorsal nearer snout than caudal base, well in front of anal; base about 1.8 in its longest ray. Ventrals 2.2 in head, longer than caudal base, slightly nearer pectorals than anal. Pectorals longer than ventrals, just reaching insertion of latter. Anal long, about equal body depth, twice length of peduncle; height slightly less than ventrals.

This description is based on Nos. 23931 and 23943, 90 and 95 mm.

LUZON, Cagayan Province, Buguey, Barrio Mission, No. 12884, 68 mm, December 9, 1905: Ilocos Norte Province, Bangui, Barrio Caunayan, Nos. 14366, 23920–23, 81–91 mm, August 19, 1926: La Union Province, Luna, No. 14305, 55 mm, August 10, 1926: Manila, Manila market, Nos. 524, 977, 83–69 mm, July, 1907; Nos. 6798, 6805, 62–65 mm, June, 1910: Rizal Province, Pasay, No. 12464, 70 mm, October 17, 1905: Batangas Province, Batangas, No. 2225, 67 mm, June 16, 1908: Albay Province, Legaspi, Legaspi market, Nos. 13330, 23930–50, 81–100 mm, February 2, 1926. LEYTE, Leyte Province, Cabalian, Nos. 10829,

23792–95, 79–91 mm, May 24, 1922. PANAY, Iloilo Province, Estancia, Nos. 23914–17, 86 mm, July, 1922. NEGROS, Oriental Negros Province, Polo Plantation, No. 15444, 92 mm, August 21, 1927. BANTAYAN, Cebu Province, Bantayan, Nos. 5961, 5966, 5969, 54–70 mm, May, 1909. MINDANAO, Misamis Province, Cagayan, No. 1452, 78 mm, September 8, 1907; No. 1557, 84 mm, September 12, 1907: Surigao Province, Surigao, No. 10902, 92 mm, June 5, 1922: Zamboanga Province, Zamboanga, Nos. 2897, 2899, 21472, 23809–10, 58–88 mm, April 10, 1908; No. 2978, 53 mm, April 13, 1908; No. 4195, 49 mm, May 28, 1908; Nos. 23802–03, 51–69 mm, June, 1908: Davao Province, Davao, Nos. 3325, 3329, 23800–01, 23806–08, 42–88 mm, April 24, 1908; No. 3468, 94 mm, April 26, 1908; No. 4540, 65 mm, April 21, 1908. SAMAL, Davao Province, Samal, Nos. 3574, 23804–05, 32–73 mm, April 29, 1908.

Genus STOLEPHORUS Lacépède

Body elongate. Scales thin, deciduous; not more than 7 prominent spiny scutes between pectorals and ventrals. Snout prominent; maxillary may be produced up to gill opening. Dorsal without small predorsal spine, placed totally or partly in front of anal. Anal short with 16 to 23 rays. Upper pectoral ray not produced. Teeth present on jaws, vomer, palatines, pterygoids, and tongue. Branchiostegals 11 to 13; caudal peduncle at least twice as long as high at its end. A silvery band present along the sides.

This genus is represented by four species in the Philippines, one of which is not present in the collection.

Key to the Philippine species of Stolephorus.

a^1. Origin of anal behind dorsal; anal about 6 in length.
S. heterolobus **Rüppell.**

a^2. Origin of anal below dorsal.
  b^1. Five to seven spiny abdominal scutes present between pectorals and ventrals; maxillary produced to gill opening; anal 5.4 to 5.8 in length ..... *S. commersonii* (Lacépède).
  b^2. Four to five abdominal scutes between pectorals and ventrals.
    c^1. Maxillary reaching to front border of preoperculum; anal 6 to 6.2 in length ..... *S. indicus* (van Hasselt).
    c^2. Maxillary reaching gill opening; anal 5 to 5.4 in length.
S. tri (Bleeker).

STOLEPHORUS COMMERSONII Lacépède. Dilis; bolinao. Plate 2, fig. 6.

Stolephorus commersonii LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 382; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 45; CHAUDHURI, Mem. Indian Mus. 5 (1916) 426.

Engraulis Brownii CUVIER and VALENCIENNES, Hist. Nat. Poiss. 21 (1848) 29 (ex parte); KNER, Fische Novarra Exp. (1865–1867) 332.
Engraulis commersonianus GÜNTHER, Cat. Brit. Mus. 7 (1868); DAY, Fishes of India 4°. (1878–1888) 629.
Stolephorus commersonianus BLEEKER, Atl. Ichth. 6 (1866–72) 128.
Anchovia commersoniana JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 5.
Anchovia commersonii FOWLER, Copeia No. 58 (June, 1918) 62.
Engraulis commersonii FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 258.

Head 3.7–4; depth 4.8–5.2; dorsal 14–15; anal 19–20; scales 37–40 in median lateral series, 8 in transverse series; 15–18 predorsals; 5–7 abdominal scutes, with sharp spines, between ventrals and pectorals.

Body elongate, slightly compressed; dorsal and ventral profiles equally convex. Mouth large, maxillary extending almost to gill opening, broad behind and with large teeth inserted at wide intervals among minute teeth. Snout less than eye diameter which is 3.6 in head. Tubercles on cheek, postorbital, preopercle, and top of head. Interorbital about an eye. Gill rakers 20 to 21, spiny on inner edge, slightly flattened, rather slender, about twice gill filaments, slightly less than eye. Scales very deciduous, large, with a variable number of transverse and longitudinal striæ which are often anastomosing and reticulate; margins smooth.

Dorsal slightly nearer snout tip than caudal base; base less than height, about 2 in head. Anal short, 5.4 to 5.8, inserted below last rays of dorsal. Pectorals less than maxillary, about 1.7 in head. Ventrals longer than orbit, slightly nearer pectorals than anal, ahead of dorsal origin.

With a prominent silvery lateral band which attains greatest width posteriorly. Top of head, nape, upper portion of operculum, lateral band, base of dorsal, and whole caudal fin powdered with minute melanophores.

Described from Nos. 7896, 41182, 41183, and 41184, ranging in size from 37 to 70 mm, collected from Carigara, Leyte Province, March 10, 1913.

LUZON, Manila, Manila market, Nos. 6855–57, 57–58 mm, July, 1915. SAMAR, Samar Province, Catbalogan, No. 12500, 54–62 mm, September 19, 1925. LEYTE, Leyte Province, Carigara, Nos. 7896, 41182–41184 (212 specimens), 37–70 mm, March 10, 1913.

STOLEPHORUS INDICUS (van Hasselt). Tuakang or dilis. Plate 2, fig. 8.

Engraulis indicus VAN HASSELT, Algemeene Konst en Letterbode (1823) 329; DAY, Fishes of India 4°. (1878–1888) 629; STEINDACHNER, Sitz. Akad. Wiss. Wien 115 (1906) 1424; GÜNTHER, Fische der Südsee 3 (1909–1910) 377; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 259.

Engraulis albus SWAINSON, Fishes 2 (1839) 293.

Engraulis balinensis BLEEKER, Verh. Bat. Gen. 22 (1849) 11.

Engraulis brownii CANTOR, Journ. Asiat. Soc. Bengal 18 (1849) 1285 (nec Gaimard); DAY, Fish. Malabar (1865) 237; PLAYFAIR and GÜNTHER, Fish. Zanz. (1866) 123.

Engraulis russelli BLEEKER, Verh. Bat. Gen. 24 (1852) 38; GÜNTHER, Cat. Brit. Mus. 7 (1868) 790.

Engraulis samaninan THIOLLIERE, Fauna Woodlark (1857) 208.

Stolephorus indicus BLEEKER, Atl. Ichth. 6 (1866-1872) 127; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 46; CHAUDHURI, Mem. Indian Mus. 5 (1916) 425.

Anchovia indica JORDAN and HERRE, Proc. U. S. Nat. Mus. 31 (1906) 638; JORDAN and SEALE, Bull. U. S. Fish. 26 (1906) 5; EVERMANN and SEALE, Bull. U. S. Fish. 26 (1906) 54.

Engraulis indica FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 33.

Head 3.8–4.2; depth 5.2–5.5; dorsal 16; anal 19–20; scales 37–40 in median lateral series; 8–9 in transverse series; 19–20 predorsals; 4 spiny abdominal scutes between ventrals and pectorals.

Body elongate, slightly compressed; profiles more or less equally convex, with a prominent silvery band along sides, greatest width about snout length. Caudal peduncle long, about head without operculum, 4.5. Snout prominent, slightly more than 2 in eye; maxillary flat, broad, reaching to front border of preopercle. Top of head laterally convex, flat dorsally, crested at median line; interorbital 1.3 in eye which is 3.3 to 3.5 in head. Gill rakers 20 to 22, flattened, spinous on inner edge, with characteristic furrow along center of flat surfaces. Branchiostegals 11. Scales very deciduous, large, with 4 to 9 crenulations arising from basal margin extending to about middle portion and ending posteriorly as groove of regular and distinct serrations of the margin. Basal margin lined by 2 to 4 layers of thick-walled reticula, the marginal ones being produced anteriorly to a point giving margin a comblike aspect.

Dorsal nearer snout than caudal; base greater than height, about twice orbit. Anal short, 6 to 6.2, well advanced, less than caudal peduncle, inserted about last third of dorsal base. Ven-

trals slightly longer than an orbit, inserted about midway from pectorals and anal. Pectoral slightly more than 2 in head; not reaching ventrals. With a characteristic black heart-shaped spot on postfrontal and a brown one on nape.

The above description is based on Nos. 12358, 23915, 23916, and 23929, 87 to 93 mm, collected from San Pedro Bay, near Basey, Samar, September 17, 1925.

LUZON, La Union Province, Damortis, Rosario, Nos. 14289, 23821–23, 64–89 mm, August 4, 1926: Rizal Province, Malabon, No. 753, 107 mm, July 18, 1907; Pasay, Nos. 12464, 23924, 72–73 mm, October 17, 1925: Manila, Manila market, No. 819, 82 mm, June 17, 1907; No. 928, 97 mm, May, 1907; No. 10964, 78 mm, 1922; Nos. 23971–75, 78–80 mm, 1912; Divisoria Market, Nos. 41248–49, 21248–9, 95–100 mm, March 13, 1931: Batangas Province, Balayan, Nos. 41221, 41243, 64–78 mm, December, 1932. MINDORO, Mindoro Province, Calapan, No. 10344, 99 mm, January, 1923; Nos. 23797–99, 96–100 mm, January, 1921. LEYTE, Leyte Province, Carigara, Nos. 14789, 23814, 98–104 mm, December, 1926; Nos. 7937, 7942, 97–99 mm, December 11, 1913. SAMAR, Samar Province, San Pedro Bay, near Basey, Nos. 23926–29, 86–91 mm, September 17, 1925. NEGROS, Negros Oriental Province, Zamboanguita, Nos. 13905, 23918–19, 86–104 mm, February 22, 1926: Occidental Negros Province, Licab, Nos. 21244–47, 107–108 mm, August 29, 1929; Sicaba, Nos. 41244, 41247, 110 mm, August, 1929. GUIMARAS, Iloilo Province, West coast of Guimaras Island, No. 41314, 35–68 mm, (22 young specimens), December 18, 1933.

STOLEPHORUS TRI (Bleeker). Plate 2, fig. 14.

Engraulis tri BLEEKER, Verh. Bat. Gen. 24 (1852) 40; GÜNTHER, Cat. Brit. Mus. 7 (1868) 389; VON MARTENS, Exp. Ostasien, Zool. 1 (1876) 404; DAY, Fishes of India 4°. (1878–1888) 630; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 259.

Stolephorus tri BLEEKER, Atl. Ichth. 6 (1866–72) 128; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 47; CHAUDHURI, Mem. Indian Mus. 5 (1916) 426.

Head 3.7–4; depth 4.5–4.7; dorsal 14; anal 20–22; scales 30–32 in median lateral series along silvery band; 8–9 in transverse series; 19–23 predorsals; 4–6 spiny scutes between pectorals and ventrals.

Body elongate, more compressed than *S. indicus*, but with greater depth; ventral and dorsal profiles subequal. Caudal peduncle long, about 1.7 in head. Mouth large; maxillary flat, broad behind mandibular joint and extending as a blunt point

to edge of operculum. Snout less than eye which is 3 in head. Interorbital about an eye; top of head with sharp median keel. Gill rakers 22, spiny on inner edge, twice length of branchial filaments. Branchiostegals 13. Scales very deciduous, large, with 10 to 15 transverse continuous striæ; margin nonserrated.

Dorsal nearer caudal base than snout tip; base about its height and caudal peduncle. Anal advanced, 5 to 5.4, about equal to head without snout, height equals snout plus eye. Pectoral shorter than maxillary not reaching ventral which is slightly longer than eye diameter. Anal inserted midway between pectoral and anal.

With a characteristic dark brown spot on top of head behind interorbital divided into two halves by the median keel.

The above description is based on No. 23811, 72 mm, from Borongan, Samar, September 3, 1907, and No. 23925, 64 mm, from Carigara, Leyte, December 1, 1926.

LUZON, Manila, Manila market, Nos. 319, 416, 82 mm, June 27, 1907; No. 535, 75 mm, July 10, 1907: Bataan Province, Orani, Nos. 10949, 23958, 23970, 48–88 mm, April 23, 1923: South coast of Luzon, Nos. 375, 380, 382, 58–91 mm, June, 1907. SAMAR, Samar Province, Borongan, Nos. 1170, 23811–12, 62–74 mm, Dec. 3, 1907. GUIMARAS, Iloilo Province, West coast of Guimaras Is., No. 41147, 29–72 mm, (16 young specimens), December 18, 1933.

This species is close to *S. indicus* in having the same number of scutes, and the same characteristic mark on top of head, but it differs in that its maxillary extends to the margin of operculum. It is similar to *S. commersonii* in the extent of the maxillary but is easily distinguished from it in the number of scutes and in body proportions.

CLUPEIDÆ

Body oblong, ventrally compressed with the belly keeled with scutes along edge. Snout never overshot; teeth either small or wanting. Mouth bordered by intermaxillaries but principally by maxillaries which have two supplemental bones. Pseudobranchiæ present and gill rakers slender. Scales thin, regular or pectinate, perforate or entire, and crenulate or smooth.

Key to the Philippine genera of Clupeidæ.

a^1. Anal fin moderate, with 15 to 25 soft rays; ventrals well developed, jaws equal.

b^1. Origin of dorsal behind that of ventrals; vomerine teeth present. *Clupeoides.*

b^2. Origin of dorsal before that of ventrals; no vomerine teeth.

c^1. No teeth in jaws; last two anal rays enlarged; scales with transverse striæ, interrupted..... *Sardinella.*

c^2. Teeth present in jaws; last anal rays not enlarged; scales with mostly continuous transverse striæ..... *Harengula.*

a^2. Anal fin with very long base; with more than 25 soft rays; ventrals small or wanting; dorsal fin present; lower jaw prominent.... *Ilisha.*

Genus CLUPEOIDES Bleeker

Body oblong, compressed, with ventral profile much more convex than dorsal. Scales thin but firm, ventral scutes prominent. Origin of ventrals ahead of or on same level as that of dorsal. Anal fin single. Teeth present on jaws, palatines, pterygoids, and vomer.

One Philippine species is known.

CLUPEOIDES LILE (Cuvier and Valenciennes). Silag. Plate 2, fig. 7.

Meletta lile CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 378.

Alausa champil CANTOR, Journ. Asiat. Soc. Bengal (1850) 1284 (nec Gray).

Rogenia argyrotaenia BLEEKER, Verh. Bat. Gen. 24 (1852) 26; BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 457; KNER, Fische Novara Exp. (1865–67) 328.

Clupea argyrotaenia GÜNTHER, Cat. Brit. Mus. 7 (1868) 423.

Clupea (Clupeoides) argyrotaenia BLEEKER, Atl. Ichth. 6 (1872) 101.

Clupea lile DAY, Fishes of India 4°. (1878–88) 638.

Harengula chrysotaenia JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 (1906) 187.

Clupeoides lile WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 57; FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 31; CHAUDHURI, Mem. Indian Mus. 5 (1916) 426.

Head 4.2–4.5; depth 2.8–3.2; dorsal 16; anal 17; scales 36–38 in median lateral series; 9 in transverse series; 15–17 predorsals; 28 abdominal scutes, 17 being preventrals.

Body strongly compressed, abdomen extremely cultrate, sharp, bordered by prominent and firm scutes. Ventral profile greatly convex; dorsal profile slightly convex, keeled from nape to dorsal origin. Length of caudal peduncle slightly less than its least depth, 2.3 in head. Snout less than eye which is 2.6 to 2.8 in head. Gill rakers 37 to 40, finely lanceolate, smooth, about as long as filaments, about radius of eye. Pseudobranchiæ 12 to 15. Scales rather adherent, depth greater than length, with 1 to 3 continuous transverse striations; posterior margin weakly serrate.

Dorsal nearer snout than caudal, height about as long as base. Anal low, base about 1.7 times caudal peduncle, slightly

less than dorsal base and about 2 in body depth. Pectorals rather long, equal head measured from snout tip. Ventrals slightly more than 2 in head, about 1.6 in pectorals midway between snout tip and caudal peduncle and between pectorals and anal; anal opening depressed between last abdominal scute and anal fin.

Dorsal margin, post frontal, tip of snout, caudal fin, and base of caudal with dark spots.

The above description is based on three specimens.

LUZON, Camarines Sur Province, Barrio Sibubu, Nos. 13136, 2313, 54–67 mm, January 13, 1926. PANAY, Iloilo Province, Molo, No. 15467, 74 mm, August 5, 1927.

Genus SARDINELLA Valenciennes

Body compressed; belly keeled, with scutes; no distinct median notch in upper jaw, teeth feeble on palatines and tongue; opercle without radiating striæ; pseudobranchiæ present; branchiostegals 6; scales large, firm, with interrupted striæ; anal long, last two rays enlarged; ventral opposite dorsal.

Key to the Philippine species of Sardinella.

a^1. Belly obtuse, not sharp-edged; postventral scutes small and flatly carinated.
  b^1. Maxillary reaches up to level of front edge of eye; 14 or 15 postventral abdominal scutes.
    c^1. A longitudinal band present, often with a series of dark spots; 30 gill rakers ..... *S. leiogaster* (Cuvier).
    c^2. No lateral band; 40 gill rakers..... *S. sirm* (Rüppell).
  b^2. Maxillary distinctly distant from level of front edge of eye; 12 postventral abdominal scutes; no lateral band; 28 gill rakers. *S. clupeoides* (Bleeker).
a^2. Belly compressed, with sharp edge; medium scutes.
  b^1. Scales in median lateral series less than 40. *S. jussieu* (Lacépède).
  b^2. Scales in median lateral series 40 or more.
    c^1. Depth 3 to 4 in standard length.
      d^1. Scales in median lateral series about 40. *S. melanura* (Cuvier and Valenciennes).
      d^2. Scales in median lateral series more than 50.
        e^1. Scales regular, entire, not perforate; gill rakers smooth, 95 to 110 ..... *S. samarensis* sp. nov.
        e^2. Scales pectinate, fenestrate.
          f^1. Depth 3.8 to 4 in length. *S. fimbriata* (Cuvier and Valenciennes).
          f^2. Depth 3 to 3.2 in length..... *S. perforata* (Cantor).
    c^2. Depth 4 or more.

d^1. Scales in transverse series 12 to 13; eye 4 to 4.5; depth about 4; teeth on palatines, pterygoid, and tongue; anal 13 to 16; gill rakers more than 140.
S. longiceps (Cuvier and Valenciennes).

d^2. Scales in transverse series 9 or 10; eye 3.5; depth 4.5 to 5; teeth on tongue only; anal 20; gill rakers 32.
S. schrammi (Bleeker).

Of the above, *S. leiogaster*, *S. clupeoides*, and *S. schrammi* are not represented in the collection.

SARDINELLA SIRM (Rüppell). Plate 2, fig. 4.

Clupea sirm RÜPPELL, Neue Wirbelthiere (1835–1840) 77; GÜNTHER, Cat. Brit. 7 (1868) 425; GÜNTHER, Fische der Südsee 3 (1909–1910) 383.

Sardinella leiogastroides BLEEKER, Nat. Tijdschr. Ned. Ind. 7 (1854) 255.

Clupea (*Amblygaster*) *leiogastroides* BLEEKER, Atl. Ichth. 6 (1872) 102.

Sardinella sirm JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 1905 (1906) 186; FOWLER, Mem. B. P. Bishop Mus. 10 (1928).

Clupea (*Amblygaster*) *sirm* WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 62.

Head 4–4.2; depth 4.6–4.8; dorsal 18; anal 18; scales 44–45 in median lateral series; 10–11 in transverse series; 13–14 predorsals; 16 preventral, and 15 postventral scutes.

Body moderately compressed; dorsal profile more convex than ventral. Least depth of caudal peduncle equal to its length. Head width 2 in its length. Snout width about 1.7 in its length which is 3.2 in head. Eye advanced, 3.5 to 3.7 in head. Maxillary barely reaches front margin of eye, about 2.5 in head. Teeth on palatine, tongue, and pterygoid. Interorbital venulose, its width equal to orbit. Distinct striation on preopercle, suborbital, and postfrontal. Gill rakers 40 to 41, stout, lanceolate, fairly rigid, spinulated on compressed sides, smooth on edges; length more than a radius of orbit, 1.6 in branchial filaments; 20 pseudobranchiæ. Scales deciduous, large, entire; posterior margin uniformly serrated, indistinctly crenulate; 3 to 6 transverse striæ which are usually all interrupted at middle, scale close to that of *S. longiceps* but differs from this in having uniform weak serration on margin, in having usually no continuous transverse striæ, and in being relatively larger.

Dorsal origin nearer snout tip than caudal base; base longer than height, 2.2 to 2.4 in head. Caudal deeply forked, lobes shorter than head, covered with small alar scales. Pectorals 1.5 in head, longer than height of dorsal, first ray stout, hard.

Ventral insertion below middle of dorsal, nearer pectoral than anal, 1.7 in pectoral, less than dorsal base. Anal base 2.5 times its height, about height of dorsal.

The above description is based on No. 13277, Legaspi, Albay Province, Luzon, February 2, 1926, and Nos. 21388–89, Sulade Island, Sulu Province, November 7, 1927, 173–191 mm.

LUZON, Batangas Province, Nasugbu, Barrio Papaya, No. 13265, 175 mm, January 13, 1926; Albay Province, Legaspi market, Nos. 21469–77, 13277, 15127, 58–173 mm, September 21, 1924. POLILLO, Tayabas Province, Polillo, No. 12597, 180 mm, September 25, 1925. MINDORO, Mindoro Province, Calapan, Nos. 11423, 21411–12, 129–130 mm, January 6, 1923; Bulalacao Bay, No. 14626, 160 mm, December 20, 1926; Pinamalayan, Nos. 6821, 21490. BANTAYAN, Cebu Province, Bantayan, Nos. 5957, 5970, 5989, 50–124 mm, May, 1909. NEGROS, Negros Oriental Province, Dumaguete, Nos. 15016, 21435, 171–172 mm, March 15, 1927. CAMIGUIN, Misamis Province, Catarman, Nos. 15020, 21440, 165–169 mm, February 10, 1927. MINDANAO, Misamis Province, Cagayan, No. 1451, 69 mm, September 8, 1907; Nos. 1745, 1759–60, 21310, 57–80 mm, September 15–17, 1907; No. 21308, 34 mm, September 13, 1908, Gingoog, Barrio Odiongan, No. 21423, 93 mm, February, 1927: Agusan Province, Butuan Bay, Nos. 1903, 1905, 84–97 mm, September 25, 1907: Davao Province, Davao, No. 3095, 80 mm, April 20, 1908; Nos. 3311, 3320, 92–118 mm, April 23, 1908; Nos. 3398, 3406, 60–67 mm, April 25, 1908: Zamboanga Province, Zamboanga, No. 4478, 65 mm, June 16, 1908; Nos. 21309–21313, 34–64 mm, 13, 1908. SAMAL, Davao Province, Samal, Nos. 3629–3631, 159–166 mm, May 1, 1908. JOLO, Sulu Province, Jolo, Nos. 2395, 2402, 2405, 2423, 24 to 150 mm, February, 1908. BUNGAU, Sulu Province, No. 13860, 178 mm, April 15, 1926. SULADE, Sulu Province, Nos. 15734, 21388–89, 21436, 171–191 mm, November 7, 1927.

SARDINELLA JUSSIEU (Lacépède). Plate 2, fig. 2.

Clupanodon jussieu LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 469–471.

Clupea jussieui GÜNTHER, Cat. Brit. Mus. 7 (1868) 430.

Clupea otaitensis (Solander) CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 257.

Spratella fimbriata SCHMELTZ, Cat. Mus. Godeffroy 4 (1869) 25.

Clupea tembang GÜNTHER, Cat. Brit. Mus. 7 (1868) 426; SCHMELTZ, Cat. Mus. Godeffroy 5 (1874) 36; GÜNTHER, Report Voyage "Challenger" 1 (1880) 36.

Clupea gibbosa GÜNTHER, Fische der Sudsee 3 (1909–1910) 381.

Harengula sundaica KENDALL and GOLDSBOROUGH, Mem. Mus. Comp. Zool. 26 (1911) 243.

Clupea exile KISHINOUYE, Journ. Coll. of Agr. Tokyo 2 (1911) 384.
Sardinella jussieu FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 257; Mem. B. P. Bishop Mus. 10 (1928) 30.

Head 4–4.2; depth 3.5–3.7; dorsal 16–17; anal 17; scales 37–39 in median lateral series; 10–11 in transverse series; predorsals 13–14; 16–17 preventral scutes, 12–13 postventrals.

Body spindle-shaped, compressed; belly cultrate with sharp rather prominent scutes; dorsal profile less convex than ventral. Caudal peduncle deep, least depth 1.2 times length which is 2.6 in head. Head very close to *S. fimbriata;* width 2.2 to 2.3 in its length. Snout width slightly narrower than its length which equals eye. Maxillary 2.3 in head, barely reaching below front margin of pupil. Interorbital equal to eye, slightly convex; postocular part of head with distinct striæ. Extensive venules on cheek, preopercle, and dorsal half of operculum. Gill rakers 45 to 49, lanceolate, broad, smooth, about as long as gill filaments. Scales large, adherent, nonfenestrate; posterior margin irregularly serrate, with 4 to 6 transverse striæ, one continuous.

Dorsal origin 1.3 times nearer snout tip than caudal base; base shorter than height, 1.7 in head, slightly more than 2 in body depth. Anal low, 1.3 in head, longer than dorsal base. Pectorals slightly shorter than anal, equal head minus snout. Ventrals 1.4 times longer than orbit, midway between pectorals and anal, below first quarter of dorsal.

This species is closest to *Harengula dispilonotus* in scale and gill raker count and to *Sardinella fimbriata* in the shape of the head. It differs, however, from the former in having the transverse striæ in the scales broken and in having a protruding snout. It differs from *S. fimbriata* in the scale and gill raker count and in the structure of the scales.

LUZON, Ilocos Sur Province, Santa Maria, Nos. 11200, 21494, 21495, 93–96 mm, January 23, 1923.

SARDINELLA MELANURA (Cuvier and Valenciennes). Plate 2, fig. 13.

Alausa melanura CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 324.
Harengula (Paralosa) valenciennesi BLEEKER, Verh. Akad. Amsterdam (2) (1868) 300 (nomen solum).
Clupea melanura GÜNTHER, Cat. Brit. Mus. 7 (1868) 449; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.
Clupea (Harengula) melanurus Bleeker, Atl. Ichth. 6 (1872) 111.
Clupea (Alausa) melanura VON MARTENS, Exp. Ostasien, Zool. 1 (1876) 405.
Harengula melanura SAUVAGE, Poiss. Madagas. (1891) 492.
Harengula vanicoris JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 (1906) 187.

Clupea (*Harengula*) *melanura* WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 72.

Sardinella melanura FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 257.

Head 3.8; depth 3.5–3.7; dorsal 15–17; anal 18–21; scales 38–40 in median lateral series; 10–11 in transverse series, 16–17 preventral scutes; 11 postventrals.

Body compressed, abdomen cultrate, with sharp, prominent scutes; ventral profile slightly more convex than dorsal; snout slightly concave. Caudal peduncle deep, greater than length which is 1.5 times eye diameter. Snout equals eye, about 3.3 in head; maxillary reaches to below front margin of pupil, slightly more than 2 in head. Striations on cheek, postorbital, and postfrontal. Interorbital about an eye, slightly convex, gill rakers 40 to 42, lanceolate, flattened, thickly-set, smooth. Scales moderate, rather adherent, entire, with 2 to 4 vertical striæ, 1 complete; hind border irregularly serrate; very similar to that of *S. longiceps*.

Dorsal origin nearer snout tip than caudal base, midway between snout tip and last ray of anal; length less than height which is 1.8 in head. Anal rather long, 1.6 in head. Pectorals equal head minus snout, greater than twice body depth. Ventrals 1.5 times eye, midway between pectorals and anal, below middle of dorsal.

BATAN, Batanes Province, No. 627, 70 mm, July, 1907. LEYTE, Leyte Province, Carigara, Nos. 7828–30, 37–47 mm, November 10, 1923.

SARDINELLA SAMARENSIS sp. nov. Tamban lirayan. Plate 2, fig. 11.

Head 3.8–4; depth 3.5–3.7; dorsal 18; anal 15; scales 43–45 in median lateral series; 9–11 in transverse series; 16–18 predorsals; 16–18 preventral scutes, 14–15 postventrals.

Body fusiform, compressed; dorsal profile slightly more convex than ventral; belly cultrate; scutes not very prominent. Snout width 1.4 in its length which is slightly greater than eye; tip produced to form with vertex a prominent concavity. Head width 2.4 in its length; eye 4, 1.8 nearer snout tip than hind margin of operculum. Maxillary 2.4 in head, reaches to below middle of eye. Interorbital rather concave, slightly less than orbit, equals greatest width of operculum. Postocular part of head deeply veined; venules on cheeks. Gill rakers 96 to 102, finely lanceolate, flattened, smooth, short, about half gill filaments which are 0.7 to 0.8 in eye. Scales adherent, subcircular,

nonfenestrate, with 2 to 5 transverse striæ, one usually complete; hind margin irregularly pectinate.

Dorsal 1.4 times nearer snout tip than caudal base; base depressed, equals height, about 2 in head. Anal low, 1.2 longer than dorsal, 1.7 in head, 1.6 times length of caudal peduncle. Pectorals equal anal base. Ventrals 1.5 times orbit, equidistant from pectorals and anal, inserted below middle of dorsal. Although in body shape this species is similar to *H. moluccensis* and *S. fimbriata*, its other characters are very distinct.

Samarensis, for Samar, the province and island from which the type was obtained.

Type.—No. 41217, 114 mm, collected by Mr. A. F. Umali from Barrio Cinco, Catbalogan, Samar Province, Samar Island, March 8, 1932. Two other specimens, Nos. 41218 and 41219, 104 mm, from the same place and of the same date, are also in the collection.

SARDINELLA FIMBRIATA (Cuvier and Valenciennes). Tunsoy or laolao. Plate 2, fig. 5.

Spratella fimbriata CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 263; BLEEKER, Verh. Bat. Gen. 24 (1852) 27; KNER, Fische Novara Exp. (1865–67) 329.

Clupea gibbosa BLEEKER, Journ. Ind. Arch. 3 (1849) 72; GÜNTHER, Fische der Südsee 8 (1909) 381.

Spratella tembang BLEEKER, Verh. Bat. Gen. 24 (1852) 28; KNER, Fische Novara Exp. (1865–1867) 329.

Clupea tembang GÜNTHER, Cat. Brit. Mus. 7 (1868) 426.

Clupea fimbriata GÜNTHER, Cat. Brit. Mus. 7 (1868) 427; DAY, Fishes of India 4°. (1878–1888) 637.

Clupea (Harengula) fimbriata BLEEKER, Atl. Ichth. 6 (1872) 105; WEBER and DE BEAUFORT, Verh. Akad. Amsterdam 17 No. 3 (1912) 10; Fish. Indo-Austr. Arch. 2 (1913) 75.

Clupea (Harengula) sundaica BLEEKER, Atl. Ichth. 6 (1872) 105.

Clupea (Harengula) gibbosa BLEEKER, Atl. Ichth. 6 (1872) 106.

Clupea sundaica MACLEAY, Proc. Linn. Soc. N. S. W. 4 (1879) 373; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 236.

Harengula gibbosa JORDAN and SEALE, Bull. Bur. Fish. 26 (1906) 4; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Harengula sundaica JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236.

Sardinella fimbriata FOWLER, Copeia (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 257.

Clupea (Harengus) fimbriata DERANIYAGALA, Spolia Zeylanica 15 (1929) 41.

Head 4.3; depth 3.5–3.6; dorsal 17–18; anal 18; scales 46–48 in median lateral series; 12–13 in transverse series; 17–18 predorsals; abdominal scutes, 17 preventrals, 15–16 postventrals.

Body well compressed, dorsal profile slightly convex; ventral profile sharp, more convex than upper. Caudal peduncle 2.5

in head, compressed, least depth equals its length. Head width twice its length. Snout width about 1.3 its length which is 3.5 to 3.6 in head. Eye advanced, 3.5 in head. Maxillary reaches to below anterior third of eye. Teeth absent on jaws. Interorbital flat, 4.5 in head; venules on vertex. Gill rakers 65 to 73, finely lanceolate, about 0.7 in eye, about 1.3 times gill filaments. Pseudobranchiæ 17. Scales largely adherent, often irregular; crenulate, fenestrate, distinctly pectinate; 4 or 5 vertical striæ, 1 complete.

Base of dorsal embedded in scaly sheath; origin much nearer snout tip than caudal base; longest ray 1.3 in head. Pectorals about twice ventrals. Ventral below middle of dorsal, nearer pectorals than anal, 2.5 to 2.7 in head. Anal low, depressible among scaly flaps, 1.8 in head.

The structure of the scales of this species is close to that of the scales of *S. perforata,* but the latter has a distinctly deeper body.

This description is based on No. 41167, 111 mm, obtained from Tondo, Manila, Luzon, October 18, 1930.

LUZON, Bulacan Province, Malolos, No. 15386, 111 mm, April 9, 1927; No. 21252, 94 mm, April 19, 1927: Rizal Province, Malabon, No. 649, 103 mm, July 18, 1907: Manila, Manila market, No. 88, 102 mm, May 31, 1907; No. 106, 112 mm, June 1, 1907; Nos. 211–212, 99–104 mm, June 12, 1907; Manila, No. 3, 83 mm, May 20, 1907; Nos. 6869–71, 6873, 6890, 48–123 mm, June, 1910; Nos. 11535, 21265–68, 47–66 mm, April 14, 1913; Paco Market, No. 11387, 114 mm, September 19, 1919; Tondo, Nos. 41168–73, 94–107 mm, October 18, 1930: Cavite Province, Cavite, No. 127, 68 mm, May, 1907. MINDORO, Mindoro Province, Calapan, Nos. 21246–47, 14204, 21249–50, 75–100 mm, January, 1923. PANAY, Iloilo Province, Estancia, Nos. 16177, 21253–57, 75–104 mm, August 12, 1927; Nos. 21235–39, 94–101 mm, July 19, 1927; Nos. 21431–33, 92–98 mm, July, 1922.

SARDINELLA PERFORATA (Cantor). Lapad or halubaybay. Plate 2, fig. 10.

Clupeonia perforata CANTOR, Journ. Asiat. Soc. Bengal 18 (1850) 1276.

Spratella kowala BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1851) 492.

Harengula (*Spratella*) *kowala* BLEEKER, Versl. Akad. Ams. 2 (1868) 294.

Clupea perforata GÜNTHER, Cat. Brit. Mus. 7 (1868) 424.

Clupea (*Harengula*) *perforata* BLEEKER, Atl. Ichth. 6 (1872) 110; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 74.

Sardinella perforata EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 54; FOWLER, Proc. Acad. Nat. Sci. Phila. 58 (1911) 206.

Head 3.6; depth 3.2; dorsal 18; anal 22; scales 41–46 in median lateral series; 11–13 in transverse series; predorsals 17–18; abdominal scutes, 16–18 preventrals, 12 postventrals, sharp, prominent.

Body spindle-shaped, compressed as in *S. fimbriata*, but deeper; dorsal and ventral profiles smoothly convex, more than that of *S. fimbriata*. Vertex flat, straight. Caudal peduncle deep; least depth 1.3 times its length, about 2.5 in head. Head width 2 in its length. Snout suppressed, width nearly equal length which is 3.7 in head. Eye advanced, about 3 in head. Maxillary 2.3 to 2.5 in head, extends beyond anterior margin of orbit. Interorbital slightly convex, 3.7 in head; vertex veined. Gill rakers 66, fine, lanceolate, 1.8 in orbit; gill filaments 1.2 to 1.3 in gill rakers. Pseudobranchiæ equal, 18. Scales crenulate, pectinate, distinctly fenestrate, with large, rounded holes; 4 to 5 transverse striæ, 1 complete.

Base of dorsal embedded in scaly sheath; origin nearer snout than caudal base; height 1.4 in head. Pectorals 1.2 head, twice ventrals. Ventral origin slightly in advance of middle of dorsal, nearer pectorals than anal, 2 in head. Anal low, its two last rays extensive; base 1.6 in head.

This species differs from *S. fimbriata* in having a deeper body, a greater and more prominent curvature of the ventral profile, and in having characteristic scales.

The above description is based on No. 6874, 101 mm, Manila Bay, Manila, Luzon, June, 1910.

LUZON, Manila, Manila market, Nos. 210, 275, 365, 83–90 mm, June 12–14, 1907; Nos. 11551, 21242–45, 72–102 mm, December 18, 1924; Manila, Nos. 6872, 6875–89, 56–103 mm, June, 1910: Rizal Province, Pasay, Nos. 12177, 21522–27, 72–85 mm, October 17, 1925: Cavite Province, Cavite, Nos. 118–19, 153, 80–83 mm, May 21, 1907; Salinas, Nos. 41174–78, 100 mm, October 1, 1930: Camarines Sur Province, Cabusao, Nos. 11917, 21509–14, 67–93 mm, December 21, 1918: Sorsogon Province, Bacon, Nos. 3660–61, 94–102 mm, 1904. PANAY, Iloilo Province, Estancia, Nos. 16181, 21239, 97–93 mm, July 19, 1927.

SARDINELLA LONGICEPS Cuvier and Valenciennes. Tamban; tamban lison; tuloy. Plate 2, fig. 1.

Sardinella longiceps CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 198; FOWLER, Proc. Acad. Nat. Sci. Phila. 79 (1927) 257.

Sardinella neohowii CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 198.

Alosa scombrina CUVIER and VALENCIENNES, Hist. Nat. Poiss. 20 (1847) 324.

Sardinella lemuru BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 500.
Clupea lemuru GÜNTHER, Cat. Brit. Mus. 7 (1868) 430.
Clupea scombrina GÜNTHER, Cat. Brit. Mus. 7 (1868) 448.
Clupea (*Harengula*) *lemuru* BLEEKER, Atl. Ichth. 6 (1872) 108.
Clupea longiceps DAY, Fishes of India 4°. (1878–1888) 637.
Clupea (*Harengula*) *longiceps* WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 82.
Clupea (*Harengus*) *longiceps* DERANIYAGALA, Spolia Zeylonica 15 (1929) 44.

Head 3.25–3.5; depth 4; dorsal 17; anal 13–15; scales 44–47 in median lateral series; 13–14 in transverse series; 13–16 predorsals; ventral scutes, 14–17 preventrals, 14–17 postventrals.

Body slightly compressed, fusiform. Least depth of caudal peduncle nearly equals its length, 3.5 in head. Head width 2.2 to 2.3 in its length; snout width 1.3 to 1.5 its length which is 3.5 in head measured from tip of upper jaw. Eye 4 to 4.2. Maxillary 2.3 in head, nearly reaches below middle of eye. Interorbital flat, about 5 in head. Cheek with prominent striæ on preopercle and operculum. Gill rakers 142 to 171, smooth, finely lanceolate, about 1.2 in eye, about twice gill filaments. Scales largely adherent, crenulate, entire, with 4 to 5 vertical striæ, 1 complete.

Dorsal and anal depressible in basal scaly flaps; dorsal origin nearer snout than caudal base; dorsal 2.2 to 2.3 in head. Pectorals about twice ventrals, 1.7 in head. Ventrals inserted below middle of dorsal origin, nearer anal than pectorals, 3.3 in head. Anal low, its base 2.5 in head, last ray well developed.

This species has a much longer and thicker body than most other species of the genus. It also grows much larger.

The above description is based on Nos. 41163 and 41164, 89–103 mm, Estancia, Iloilo Province, Panay, July, 1927.

LUZON, Ilocos Sur Province, Santa Maria, Nos. 11200, 21494–96, 94–101 mm, January 23, 1923: Manila, Manila market, No. 18, 140 mm, January 16, 1908: Batangas Province, Nasugbu, Barrio Papaya, No. 13265, 155 mm, January 13, 1926. POLILLO, Tayabas Province, Polillo, No. 12597, 181 mm, September 25, 1925. MINDORO, Mindoro Province, Pinamalayan, No. 6821, 158 mm, January, 1913; Calapan, No. 11423, 129 mm, January 16, 1923; Bulalacao Bay, No. 14626, 161 mm, December 20, 1926. LEYTE, Leyte Province, Cabalian, Nos. 9644 and 21414, 113 mm, June 1, 1921; Carigara, Nos. 7897–99, 69–75 mm, December 11, 1913. PANAY, Iloilo Province, Estancia, Nos. 11261, 21346–78, 128–146 mm, September, 1924; Nos. 12161, 12193, 21398–99, 21400, 21491–93, 119–146 mm, July 17, 1925;

Nos. 16183, 21269–77, 89–103 mm, June 21, 1927. NEGROS, Negros Oriental Province, Dumaguete, No. 21436, 167 mm, March 15, 1927. CAMIGUIN, Misamis Province, Catarman, No. 21440, 168 mm, February 10, 1927. MINDANAO, Zamboanga Province, Zamboanga, Nos. 4115, 4123, 4128, 4140, 90–100 mm, May 22, 1908; No. 4420, 107 mm, June 12, 1908; No. 2868, 93 mm, April 9, 1908; Dipolog, Nos. 15019, 21504–07, 108–119 mm, March 14, 1927.

Genus HARENGULA Valenciennes

Body oblong or partly oblong; abdominal scutes with distinct spine or smooth; edge of upper jaw without median notch; vomerine teeth always absent; scales firmly adnate, thin, with transverse striæ continuous or overlapping; dorsal with low scaly basal sheath; hind anal rays equal, not enlarged.

Key to the Philippine species of Harengula.

a [1]. Scales in median lateral series less than 40.
H. dispilonotus (Bleeker).

a [2]. Scales in median lateral series more than 40.
b [1]. Gill rakers less than 50.... *H. moluccensis* (Cuvier and Valenciennes).
b [2]. Gill rakers about 60, spinous..... *H. tawilis* Herre.

HARENGULA DISPILONOTUS Bleeker. Plate 2, fig. 12.

Harengula dispilonotus BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 456.

Clupea dispilonotus GÜNTHER, Cat. Brit. Mus. 7 (1868) 429; MAX WEBER, Fische Siboga Expeditie 65 (1913) 9.

Clupea (Harengula) dispilonotus BLEEKER, Atl. Ichth. 6 (1872) 112.

Harengula dispilonotus FOWLER, Proc. Acad. Nat. Sci. Phila. 85 (1933) 246.

Harengula dispilonotus HERRE, Fish. Herre 1931 Philip. Exp. (1934) 15.

Head 3.6–3.7; depth 3–3.2; dorsal 17–18; anal 19–20; scales 32–34 in median lateral series; 10 in transverse series; 15 preventral scutes; 12–13 postventrals.

Body oblong, well compressed, with trenchant abdomen lined by sharp, prominent scutes; ventral profile slightly more concave than dorsal. Caudal peduncle short, about half its least depth, less than eye diameter. Snout slightly less than eye, about 3.2 in head measured from tip of upper jaw. Maxillary reaches to below front margin of pupil. Interorbital equal, orbit flat, forming with protruding snout tip a concavity on head profile. Gill rakers 42 to 45, finely lanceolate, slightly compressed, spinous; longer than filaments, slightly longer than radius of orbit. Scales rather deciduous, round, with 3 to 6 vertical stria-

tions, all complete; similar to scales of *H. moluccensis;* margins rarely serrate. Dorsal origin 1.3 nearer snout than caudal base. Length nearly equals height, equals head without snout. Anal low, twice length of caudal peduncle, 1.6 in head. Pectorals equal base of dorsal. Ventrals 1.4 times orbit, slightly nearer anal than pectorals, below middle of dorsal.

With two characteristic dark brown spots, one at about last third of dorsal and another about an orbit posterior to the former.

MINDORO, Mindoro Province, Mangarin, No. 10976, 90 mm, 1913. PANAY, Iloilo Province, Iloilo, Nos. 14242, 21395–21397, 112 mm, July 2, 1922. BALABAC, Palawan Province, Balabac, Nos. 5014–5041, 21218, 21219, 51–54 mm, August 3, 1908.

HARENGULA MOLUCCENSIS Bleeker. Plate 2, fig. 3.

Harengula moluccensis BLEEKER, Nat. Tijdschr. Ned. Ind. 4 (1853) 609; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 4; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 53; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 239.

Harengula kunzei BLEEKER, Nat. Tijdschr. Ned. Ind. 12 (1856–1857) 209.

Clupea moluccensis GÜNTHER, Cat. Brit. Mus. 7 (1868) 427.

Clupea (*Harengula*) *moluccensis* BLEEKER, Atl. Ichth. 6 (1872) 107; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 81.

Clupea (*Harengula*) *kunzei* BLEEKER, Atl. Ichth. 6 (1866–1872) 107.

Clupea kunzei DAY, Fishes of India 4°. (1878–1888) 636; GÜNTHER, Fische der Südsee 8 (1909) 382.

Clupea (*Harengus*) *moluccensis* DERANIYAGALA, Spolia Zeylanica 15 (1929) 43.

Head 3.8; depth 3.6; dorsal 18–19; anal 17; scales 42–45 in median lateral series; 12–13 in transverse series; 12–13 predorsals; abdominal scutes, 17 preventrals, 12–13 not prominent postventrals.

Body compression and depth intermediate between *S. fimbriata* and *S. perforata;* fusiform; dorsal profile more convex than ventral. Ventral edge not sharp, as in *S. fimbriata,* less trenchant than that of *S. perforata.* Caudal peduncle shorter than deep, least depth 1.7 times length, about 2.6 in head. Head width twice length, thicker than any portion of body. Snout width greater than length, forming with eye and preorbital a deep concavity; width 3.7 in head. Eye advanced, about 3 in head. Maxillary 2.1 in head, reaches to below first third of eye. Interorbital slightly concave, depressed towards tip; vertex with few venations. Cheek extensively veined. Gill rakers 36 to 41,

length about 2 in orbit, equal to gill filaments. Pseudobranchiæ equal, 14 to 15. Scales strongly adherent, crenulate, entire, irregularly serrate; 4 to 6 transverse striæ, all, or almost all, complete.

Dorsal origin nearer snout tip than caudal base; longest ray about 1.7 in head. Pectoral 1.7 in head, 1.6 times ventrals. Ventrals inserted slightly in front middle of dorsal, equidistant from pectorals and anal; 1.8 in head. Anal depressible in scaly flaps, low, last two rays well developed; anal base 1.7 in head, equals dorsal base.

The above description is based on Nos. 2358 and 2429, 98 and 106 mm, obtained from Jolo Island, Sulu Province, February, 1908.

LUZON, Ilocos Norte Province, Bangui, Nos. 14340, 21515–19, 85 mm, August 19, 1926: Zambales Province, Olongapo, Nos. 150–151, 88 mm, May, 1907: Batangas Province, Balayan Bay, No. 2339, 90 mm, January 20, 1908: Cavite Province, Cavite, No. 128, 103 mm, May, 1907. PANAY, Iloilo Province, Estancia, No. 21434, 62 mm, July, 1922. CEBU, Cebu Province, Cebu, No. 1258, 28 mm, September 5, 1907. PALAWAN, Palawan Province, Puerto Princesa, Nos. 5487–88, 60–63 mm, August 4, 1908; Nos. 213311–12, 57 mm, August 21, 1908: BALABAC, Palawan Province, No. 21298, 57–72 mm, August 10, 1908. CAMIGUIN, Misamis Province, Camiguin, No. 608, 89 mm, June, 1907. MINDANAO, Misamis Province, Cagayan, No. 1521, 48 mm, September 9, 1907; No. 1543, 84 mm, September 12, 1907: Surigao Province, Surigao, No. 1772, 57 mm, September 17, 1907. BUNGAU, Sulu Province, Bungau, Nos. 11382, 21497–99, 87–91 mm, August 27, 1924. SIBUTU, Sulu Province, Sibutu, Nos. 13731, 21401–05, 98–108 mm, May 3, 1926.

HARENGULA TAWILIS Herre. Tawilis. Plate 2, fig. 15.

Harengula tawilis HERRE, Philip. Journ. Sci. 34 (1927) 273, pl. 3, figs. 1–6.

Head 4.2–4.5; depth 3.2–3.6; dorsal 18–19; anal 20–21; scales 40–42 in median series; 11–12 in transverse series; 11–13 predorsals; 16–18 preventrals, 11 postventrals.

Body compression, dorsal profile, and convexity similar to those of *S. perforata;* ventral profile slightly more convex, but as trenchant; body deeper. Caudal peduncle compressed, least depth 1.4 times its length. Snout width 1.2 in its length which is 3.5 in head, measured from tip of snout. Eye advanced, 3.4 in head. Maxillary reaches below third of eye, 2.3 in head.

Interorbital slightly convex, veined. Gill rakers 58 to 60, spinulose, lanceolate, 1.8 in orbit, 1.2 in gill filaments. Pseudobranchiæ 16, equal. Scales very adherent, regular, entire. Transverse striæ 4 to 6, most commonly 5, 1 to 3 continuous, the rest discontinuous, the central terminals running past each other.

Dorsal fin depressible in a sheath of scales; origin nearer snout tip than caudal base; longest ray 1.4 to 1.5 in head. Pectorals 1.6 times ventral which is 2.2 in head. Ventral origin below middle of dorsal, nearer to pectorals than to anal. Anal low, base about twice length of caudal peduncle, 1.6 in head, isometric with dorsal base.

Scales closest to those of *H. moluccensis* but differ in being less elliptical; in having several discontinuous, though overreaching, transverse striæ; in being crenulate; and in being more, though irregularly, pectinate.

The above description is based on Nos. 21316, 21317, and 21325, 85–114 mm, Lake Bombon (Taal), Batangas Province, November 8, 1925.

LUZON, Batangas Province, Bombon Lake (Taal) Nos. 15157, 23947, 26983, 89–110 mm, April, 1927; Nos. 21383, 21387, 10801, 85–90–92 mm, February 17, 1921; Nos. 13198, 21318–45, 21327, 21345, 85–115 mm, March 1, 1926; Nos. 14237, 21314–26, 97–114 mm, November 8, 1925.

Genus ILISHA (Gray) Richardson

Body oblong, much compressed. Scales thin, deciduous. Lower jaw prominent, mouth cleft oblique. Upper pectoral ray strong and broad, anal very long with 35 to 54 rays, its origin below or just behind dorsal; ventrals small, its origin in advance of dorsal. Gill rakers stout, few (about 20) spinulous all around.

One Philippine species is known.

ILISHA HOEVENII Bleeker. Tuabak. Plate 2, fig. 9.

Pellona hoevenii BLEEKER, Verh. Bat. Gen. 24 (1852) 21; DAY, Fishes of India 4°. (1878–1888) 644.

Pellona hoevenii GÜNTHER, Cat. Brit. Mus. 7 (1868) 455.

Ilisha hoevenii BLEEKER, Atl. Ichth. 6 (1872) 117; JORDAN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 5; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 (1906) 54; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 (1907) 236; FOWLER, Copeia No. 58 (June, 1918) 62; Proc. Acad. Nat. Sci. Phila. 79 (1927) 258.

Head 3.3–3.4; depth 2.7–2.9; dorsal 18; anal 36; scales 42–44 in median lateral series; 11–12 in transverse series, 10 predorsals; 27 prominent abdominal scutes, 18 being preventrals.

Body strongly compressed, deep; ventral profile more convex than dorsal; ventral edge cultrate with sharp, firm, serrature. Caudal peduncle well compressed, deep, 1.6 to 1.8 in its least depth which is 2.8 in head measured from tip of lower jaw. Head width 2 in its length. Snout width greater than length, about 3 in head. Eye advanced, 2.5 to 2.7 in head, 2.6 times snout length; maxillary extends to pupil of eye, about 1.3 times eye diameter, twice head length; distal margin of accessory bone and maxillary finely denticulated throughout; snout, with orbit, preorbital, postorbital, and interorbitals, forms a deep concavity. Teeth on intermaxillary small, but larger than those of accessory maxillary. Teeth present also in lower jaw, tongue, palatine, and pterygoid. Interorbital somewhat concave, with a prominent pair of furrowed ridges which meet posteriorly about an orbit past occiput; vertex not conspicuously veined. Suborbital veined. Gill rakers 20 to 23, coarsely lanceolate, spiny on upper margin, firm; 1.3 to 1.5 in gill filaments, about 5 in orbit. Pseudobranchiæ 20 to 22, all equal. Scales very deciduous, large, commonly subcordate, smooth, entire, unimbricated portion usually produced to an obtuse point; 4 to 6 transverse striæ, one complete, others interrupted at midportion.

Dorsal origin raised on summit of a sharp, firm keel, midway between tip of upper jaw and caudal base; behind ventrals; base length isometric with longest ray, 1.6 in head from maxillary tip, 2.3 in body depth. Caudal deeply forked. Pectorals 2.2 times ventrals, greater than dorsal base, 1.5 in head, 1.8 times its axillary scale. Ventral insertion midway between pectoral and anal origin, small; length less than an orbit. Anal low, elongate, longer than head, twice dorsal base; origin slightly behind last dorsal ray. Anal opening deeply indented behind last abdominal scute.

This species differs from all other forms of *Ilisha* in having a supplemental bone instead of a ligament between the lateral end of intermaxillary and upper end of maxillary.

The above description is based on Nos. 7810–12, 118–134 mm, Carigara, Leyte Province, Leyte Island, November 11, 1913.

LUZON, Manila, Manila market, No. 364, 96 mm, January 20, 1907; Manila, No. 6810, 108 mm, June, 1910; Divisoria market, No. 41180–81, 116–125 mm, November 15, 1930. MINDORO, Mindoro Province, Calapan, No. 21251, 60 mm, 1923. MASBATE, Masbate Province, Masbate, No. 14244, 119 mm, June 2, 1925. LEYTE, Leyte Province, Carigara, Nos. 7803, 7814–15, 7812–18, 7820, 7850, 7855, 118–134 mm, November 11, 1913. PANAY,

Antique Province, Culasi, Nos. 41112, 41179, 80–94 mm, December 15, 1933. GUIMARAS, Iloilo Province, west coast of Guimaras Island, Nos. 41311, 41325 (82 specimens), 41328 (93 specimens), 41331 (86 specimens), 27–33 mm, December 18, 1933.

STERNOPTYCHIDÆ [1]

Body short, anterior portion elevated, compressed or elongated, with "carinated contour." Eyes large, sometimes telescopic. Without barbels. Gape of mouth vertical or nearly so with upper margin constituted by the supramaxillaries and intermaxillaries. Dorsal may be preceded by spines, located about middle of body. Adipose fin low, totally or partly above hind part of anal which may be divided. Ventrals small, below or before origin of dorsal. Scales present or absent; if present, large, thin, and very deciduous. Preorbital, postorbital, and ocular luminous organs single; those on body in groups. No whitish punctiform organs on fins. Branchiostegals 5 to 11; arch near to and parallel with lower jaw. Gill rakers well developed. Pseudobranchiæ present or absent.

"Deep sea fishes, rising toward the surface at night or in stormy weather." (Jordan and Evermann, 1896).

Key to the Philippine genera of Sternoptychidæ.

a^1. Body much elevated, compressed, short, height about 1.5. Anal short, 11 to 17 rays. Pseudobranchiæ present. Eyes normal.

b^1. Dorsal fin preceded by a forked spine, without anterior dilation. No abrupt ventral constriction between trunk and tail. Covered with large, thin, and deciduous scales. Teeth on vomer. Branchiostegals 9 to 11, short..... *Polyipnus* Günther.

b^2. Dorsal fin preceded by a large transparent triangular plate. With an abrupt ventral constriction between trunk and tail which is filled by a transparent integumentary plate resembling thin cartillage. No teeth on vomer. Branchiostegals 5. *Sternoptyx* Hermann.

a^2. Body elongate, not elevated, scaleless, height about 3.7 to 3.8. Anal long, 23 to 24 rays. Dorsal short, not preceded by a strong spine or hyaline plate. Caudal emarginate. Eyes normal, pseudobranchiæ wanting ..... *Valenciennellus* Jordan and Evermann.

The record of Philippine deep-sea fishes is very incomplete. Aside from the little work done by the "Challenger" in 1873–76, no collection of the deep-sea fishes has been made in and around the Philippines.

[1] After Günther (1887), Jordan and Evermann (1896) and Weber and de Beaufort (1913).

Genus POLYIPNUS Günther

Body elevated, strongly compressed, ventral portion between trunk and tail without abrupt constriction; covered with large, very thin, and deciduous scales. Dorsal fin without anterior spinous dilation but preceded by a forked spine. Anal not divided, short, with 15 to 17 rays. Adipose fin low. Eyes normal, large. Teeth on vomer. Branchiostegals short, 9 to 11. Gill rakers rather long.

One Philippine species is known.

POLYIPNUS SPINOSUS Günther.

Polyipnus spinosus GÜNTHER, Rep. Voyage "Challenger," Deep-Sea Fishes (1887) 170; ALCOCK, Ann. & Mag. Nat. Hist. (VI) 4 (1889) 137–398; BRAUER, Deutsche Tiefsee Exp. Tiefseefische (1906) 120; MAX WEBER, Fische Siboga Expeditie 65 (1913) 22; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 130–131.

Head 3; depth 1.3–1.8; dorsal 12–13; anal 15–17; pectoral 12–14; ventral 5.

Head much higher than long, 2.5. Vertical diameter of eye 0.5 or somewhat more of length of head. Snout very short, less than pupil. Dorsal part of head with 2 serrated ridges, each beginning behind nostril and bordering a concave space, then converging towards middle of occiput and continuing as strong, diverging crests, ending in a sharp recumbent spine. Edge of preoperculum armed with a slender, clawlike spine, pointing vertically downward and serrated near its angle. Gape of mouth vertical, bordered above by slender intermaxillary and maxillary. Hinder half of latter broad, rounded behind the gape. Mandibles received within the upper jaw, their lower border denticulated. A band of minute, curved teeth on intermaxillary and mandibles, and a single series on maxilla; similar teeth on vomer. Symphysis and its inferior posterior angle with a blunt spine.

Ventral edge of body serrated, with an anterior and posterior spine, followed by a spinulous edge on each side between ventrals and anal. Origin of dorsal near middle of body, preceded by a small bifid spine. Origin of anal on posterior third of body. Low adipose fin midway between dorsal and caudal. Pectorals low in position, reaching almost as far as base of small ventrals. Anus immediately before anal. Caudal forked. Extremely thin, large, deciduous scales. Luminous organs: an oval black spot on preorbital before middle of eye, a postorbital one on the same level, a suborbital below middle of eye; a small

Genus POLYIPNUS Günther

Body elevated, strongly compressed, ventral portion between trunk and tail without abrupt constriction; covered with large, very thin, and deciduous scales. Dorsal fin without anterior spinous dilation but preceded by a forked spine. Anal not divided, short, with 15 to 17 rays. Adipose fin low. Eyes normal, large. Teeth on vomer. Branchiostegals short, 9 to 11. Gill rakers rather long.

One Philippine species is known.

POLYIPNUS SPINOSUS Günther.

Polyipnus spinosus GÜNTHER, Rep. Voyage "Challenger," Deep-Sea Fishes (1887) 170; ALCOCK, Ann. & Mag. Nat. Hist. (VI) 4 (1889) 137–398; BRAUER, Deutsche Tiefsee Exp. Tiefseefische (1906) 120; MAX WEBER, Fische Siboga Expeditie 65 (1913) 22; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 130–131.

Head 3; depth 1.3–1.8; dorsal 12–13; anal 15–17; pectoral 12–14; ventral 5.

Head much higher than long, 2.5. Vertical diameter of eye 0.5 or somewhat more of length of head. Snout very short, less than pupil. Dorsal part of head with 2 serrated ridges, each beginning behind nostril and bordering a concave space, then converging towards middle of occiput and continuing as strong, diverging crests, ending in a sharp recumbent spine. Edge of preoperculum armed with a slender, clawlike spine, pointing vertically downward and serrated near its angle. Gape of mouth vertical, bordered above by slender intermaxillary and maxillary. Hinder half of latter broad, rounded behind the gape. Mandibles received within the upper jaw, their lower border denticulated. A band of minute, curved teeth on intermaxillary and mandibles, and a single series on maxilla; similar teeth on vomer. Symphysis and its inferior posterior angle with a blunt spine.

Ventral edge of body serrated, with an anterior and posterior spine, followed by a spinulous edge on each side between ventrals and anal. Origin of dorsal near middle of body, preceded by a small bifid spine. Origin of anal on posterior third of body. Low adipose fin midway between dorsal and caudal. Pectorals low in position, reaching almost as far as base of small ventrals. Anus immediately before anal. Caudal forked. Extremely thin, large, deciduous scales. Luminous organs: an oval black spot on preorbital before middle of eye, a postorbital one on the same level, a suborbital below middle of eye; a small

opercular below level of suborbital; 6 between branchiostegal rays; a series of 6 between isthmus and base of pectorals; a series of 10 along ventral edge, between humeral and pelvic symphysis; 5 between ventrals and anal; a series of 6 to 12 above and behind anal and a series of 4.5 behind there decreasing in size posteriorly, the last above the first caudal ray; 2 above and 3 behind base of pectorals; 2 on side of trunk below middle line. Silvery, back yellowish brown. Length 85 mm.

The type species of the genus *Polyipnus* Günther (1887) is *P. spinosus*. The type specimen was obtained by the "Challenger" at Station 200, between the Philippine Islands and Borneo, at a depth of 250 fathoms.

This species is not represented in the collection. The above description is based on that of Günther (1887).

Genus STERNOPTYX Hermann

Trunk much elevated and compressed, slender tail very short; with an abrupt ventral constriction between trunk and tail which is filled by a transparent integumentary plate. Greater portion of body scaleless and covered with a silvery pigment. Dorsal fin preceded by a large triangular transparent plate. Anal short, 11 to 17 rays, undivided, incompletely developed. Adipose fin represented by a very low membranous fringe of the dorsal margin of tail. Teeth on jaws in several series, the largest teeth in a single row. No teeth on vomer. Eyes large, normal, lateral. Pseudobranchiæ present. Gill rakers moderate. Branchiostegals 5.

One Philippine species is known.

STERNOPTYX DIAPHANA Hermann.

Sternoptyx diaphana HERMANN, Der Naturforscher 16 (1781) 8; GMELIN, Syst. Nat. Linnæus (1789) 1150; GÜNTHER, Cat. Brit. Mus. 5 (1864) 387; GOODE and BEAN, Bull. Mus. Comp. Zool. 10 No. 5 (1833) 220; GÜNTHER, Rep. Voyage "Challenger" Deep-Sea Fishes (1887) 168; GILBERT and CRAMER, Proc. U. S. Nat. Mus. 19 (1897); BRAUER, Deutsche Tiefsee Exp., Tiefseefische (1906) 115; GILBERT, Bull. U. S. Fish. Comm. 23 pt. 2 (1903) 609; ZUGMAYER, Camp. Scient. Monaco 35 (1911) 54; MAX WEBER, Fische Siboga Expeditie 65 (1913) 22; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 132; FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 35.

Sternoptyx hermanni LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 613.

Dorsal 12; anal 14; head 2.6–2.8 measured along axis connecting tip of snout and lateral center of caudal peduncle; depth 1.4–1.7, taken at right angle to snout-caudal axis. Body deep, strongly compressed; belly pushed considerably downward and

forward beneath head, pectoral portion being protracted to below snout. Ventral portion of trunk abruptly narrow almost perpendicularly to a short, small, and much more compressed tail. Narrow ventral margin reaches to same level with eye, and tail region extends above level of head. Lower part between trunk and tail occupied by a transparent integumentary portion whose entire ventral margin bears the transparent anal fin. Ventral profile much more convex than dorsal and its contour disturbed by marginal spines borne on protuberances which they intensify to acuteness. A strong, hyaline, unpaired spine at angle formed by the oblique isthmus and the straight ventral margin of trunk. Two bifid closely set spines on pelvic symphysis on posterior portion of ventral margin of trunk. Anterior spine long, directed forward; posterior one short, directed posteriorly. Head short but deep, triangular, with opercular margin at longest side, and occiput as point of acute angle, the whole triangle slightly tipped backward on its upper portion. Cleft of mouth subvertical, more or less concave, with tip of snout looming forward. Snout extremely short, bordered by much reduced intermaxillary and maxillary. Lower jaw received in upper jaw; dentine translucent; postero-inferior angle with a short spine. Unequal minute teeth on margins of both jaws. Eye large, orbital socket oval, with greatest diameter on dorsoventral axis; located above and slightly advanced from symphysis of jaws; equal oral cleft. Interorbital narrow, slightly wider than the pupil. Vertex from snout tip to occiput, about equal straight ventral margin of trunk, steep, more or less straight, made concave by 2 prominent, serrate, hyaline, ridges which arise from snout tip passing low on upper margin of orbit and meeting at occipital region. Operculum proportionately drawn out dorsoventrally; soft, membranous; opercular opening correspondingly wide. Posterior limb of preopercle bordering hind part of orbit, and descending obliquely. Trunk semihyaline, its ventral side straight and keeled by a sharp, transparent lamina. Pectorals well developed, carried down to below eye with drawn thorax, barely reaching ventrals. Ventrals small, arising behind bifid spines, and received in a shallow, concave recess. A long, sharp, hyaline spine behind recess where trunk climbs to a perpendicular. Anal long, rays rudimentary, in the form of a transparent plate supported by externally visible interhæmal rays. Dorsal origin immediately or slightly behind superior pelvic symphysis, with a

prominent spine strengthened in front by a sharp triangular lamella. Lamella less finely serrate than verticle ridges, originating immediately behind rhomboid flat area which marks the occiput. Lamella has a spine which is directed backward. Adipose fin represented by a low hyaline keel which runs continuous with dorsal margin of caudal. Caudal hyaline, broad, forked; peduncle oblique, running about 45° with level of trunk. Scales absent. Gill rakers 14, tuberculate, widely spaced, about length of gill filaments.

General body color dirty brown.

LUMINOUS ORGANS.

A series of luminous spots runs along the lower edge of the abdomen, and is separated from that of the other side by a cartilaginous fold occupying the median line of the abdomen; another series runs on each side of the isthmus; a row of three above and behind the root of the ventrals, and another row of three above the vent. The luminous organs on the lower part of the tail consist anteriorly of a row of four, of which the first is prolonged towards the back as a narrow band, terminating about the middle of the depth of the body in a globular spot with a white centre; posteriorly in front of the caudal rays there is another row of four small spots . . . . A luminous organ occupies the inner side of the operculum close to its lower end; another is placed at the anterior end of the ceratohyal, and, finally, a very large glandular mass is lodged on the upper edge of the anterior end of the clavicle . . . . (Günther, 1887.)

The above description is based on one specimen, No. 15983, 27 mm, collected by the Danish Scientific Expedition, June 16, 1929, at its Station No. 3731, XIV, 119° 52′ E. Long. 14° 37′ N. Lat. about 60 miles NWW off Lubang Island, Mindoro, at a depth of 1,000 meters.

Genus VALENCIENNELLUS Jordan and Evermann

Body elongate, not elevated, strongly compressed, scaleless. Head strongly compressed; mouth wide, subvertical, maxillary broad, curved. Teeth on jaws. Luminous organs on head; a ventral series between isthmus and ventrals and between ventrals and anal, the organs touching each other; between origin of anal and caudal five groups of organs on rather large black patches. Dorsal short, not preceded by strong spine. Adipose fin low, distinct, immediately behind dorsal. Caudal emarginate. Anal long, undivided, with 23 to 24 rays. Eyes normal, large, lateral. Pseudobranchiæ wanting.

One Philippine species is known.

VALENCIENNELLUS TRIPUNCTULATUS (Esmark).

Maurolicus tripunctulatus ESMARK, Vidensk. Selskaps Forhandl. Christiana (1870) 488; LÜTKE, Spolia Atlantica, Scopelini (1892) 269.

Valenciennellus tripunctulatus JORDAN and EVERMANN, Fishes of North and Middle America 1 (1896) 278; MAX WEBER, Fische Siboga Expeditie 65 (1913) 20; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 2 (1913) 136.

Head 3.3–3.7; depth 3.7–3.8; dorsal 7; anal 24; pectoral 10; ventral 7.

Body elongate, tapering posteriorly. Eye 2.5, about equal snout. Gape of mouth very oblique, nearly vertical. Both jaws with minute teeth. No teeth on vomer. Origin of dorsal opposite first rays of anal, in the middle of the length. Pectorals about 0.7 to 0.8 of head, reach to ventrals which are short. Scales wanting.

LUMINOUS ORGANS

Luminous organs: 16–17 organs, touching each other, in a ventral series between isthmus and ventrals. A lateral series of 10, four of which before pectorals, the fifth above the pectorals, 2 somewhat smaller ones, close together, behind the pectorals and followed at a short distance by the larger 3 equally distant, hindermost. Between ventrals and anal a series of 5, touching each other. These and the lateral series of organs consists of round organs, partly silvery, partly blackish, bordered by a metallic reddish patch above. Between origin of anal and caudal 5 equally distant black spots the first, second and third containing 3 white rounded organs, the fourth 2, and the fifth 4; an antorbital organ below nostril, a series of 4 organs underneath the cheek; 2 opercular ones, one behind the eye and one behind the maxilla, 2 or 3 on the gill membrane. Brownish operculum and belly silvery. A series of about 15–17 black spots between operculum and caudal . . . (Weber and the Beaufort, 1913, p. 137.)

This species is represented in the collection by No. 15984, a single, mutilated specimen, 26 mm long, collected by the Danish Scientific Expedition June 16, 1929, at Station No. 3731, VI, 119° 52″ E. Long. 14° 37′ N. Lat. about 60 miles NWW off Lubang Island, Mindoro, at a depth of 1,000 meters.

As far as is known this is the first locality record of *V. tripunctulatus* from Philippine waters.

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ILLUSTRATIONS

PLATE 1. SCALES OF PHILIPPINE ISOSPONDYLOUS FISHES

FIG. 1. *Nematalosa nasus*, × 6.
2. *Dussumieria hasseltii*, × 6.
3. *Chanos chanos*, × 5.
4. *Megalops cyprinoides*, × 3.
5. *Dussumieria acuta*, × 6.
6. *Thrissocles setirostris*, × 6.
7. *Thrissina baelama*, × 6.
8. *Scutengraulis mystax*, × 6.
9. *Chirocentrus dorab*, × 6.
10. *Scutengraulis hamiltonii*, × 3.
11. *Elops hawaiensis*, × 9.
12. *Albula vulpes*, × 3.
13. *Anodontostoma chacunda*, × 5.

PLATE 2. SCALES OF PHILIPPINE ISOSPONDYLOUS FISHES

FIG. 1. *Sardinella longiceps*, × 6.
2. *Sardinella jussieu*, × 5.
3. *Harengula moluccensis*, × 5.
4. *Sardinella sirm*, × 5.
5. *Sardinella fimbriata*, × 6.
6. *Stolephorus commersonii*, × 6.
7. *Clupeoides lile*, × 6.
8. *Stolephorus indicus*, × 6.
9. *Ilisha hoeveni*, × 6.
10. *Sardinella perforata*, × 4.
11. *Sardinella samarensis*, × 6.
12. *Harengula dispilonotus*, × 6.
13. *Sardinella melanura*.
14. *Stolephorus tri*, × 6.
15. *Harengula tawilis*, × 6.

PLATE 3

FIG. 1. *Anodontostoma chacunda;* head, × 1.
2. *Nematalosa nasus;* head, × 1.
3. *Clupanodon punctatus;* head, × 1.

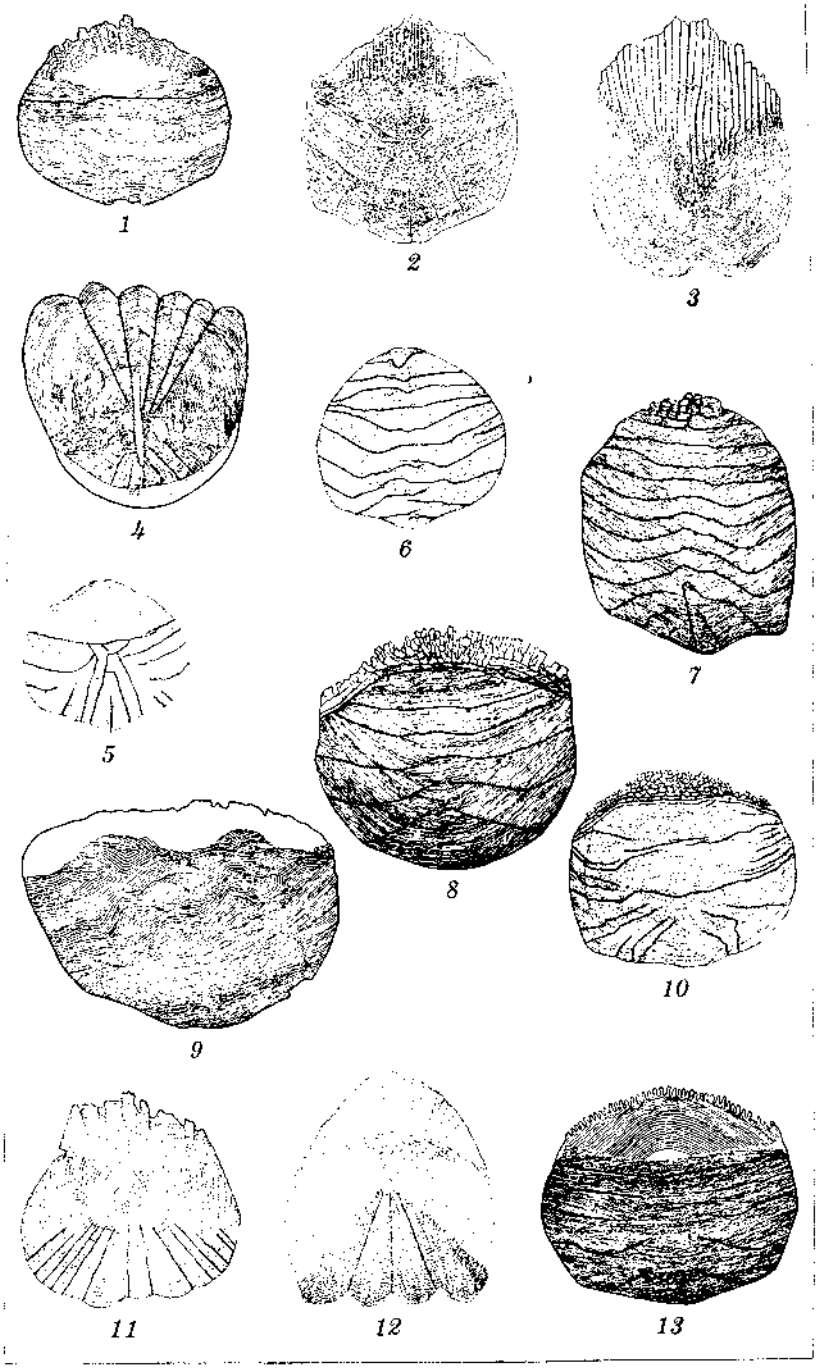


PLATE 1.

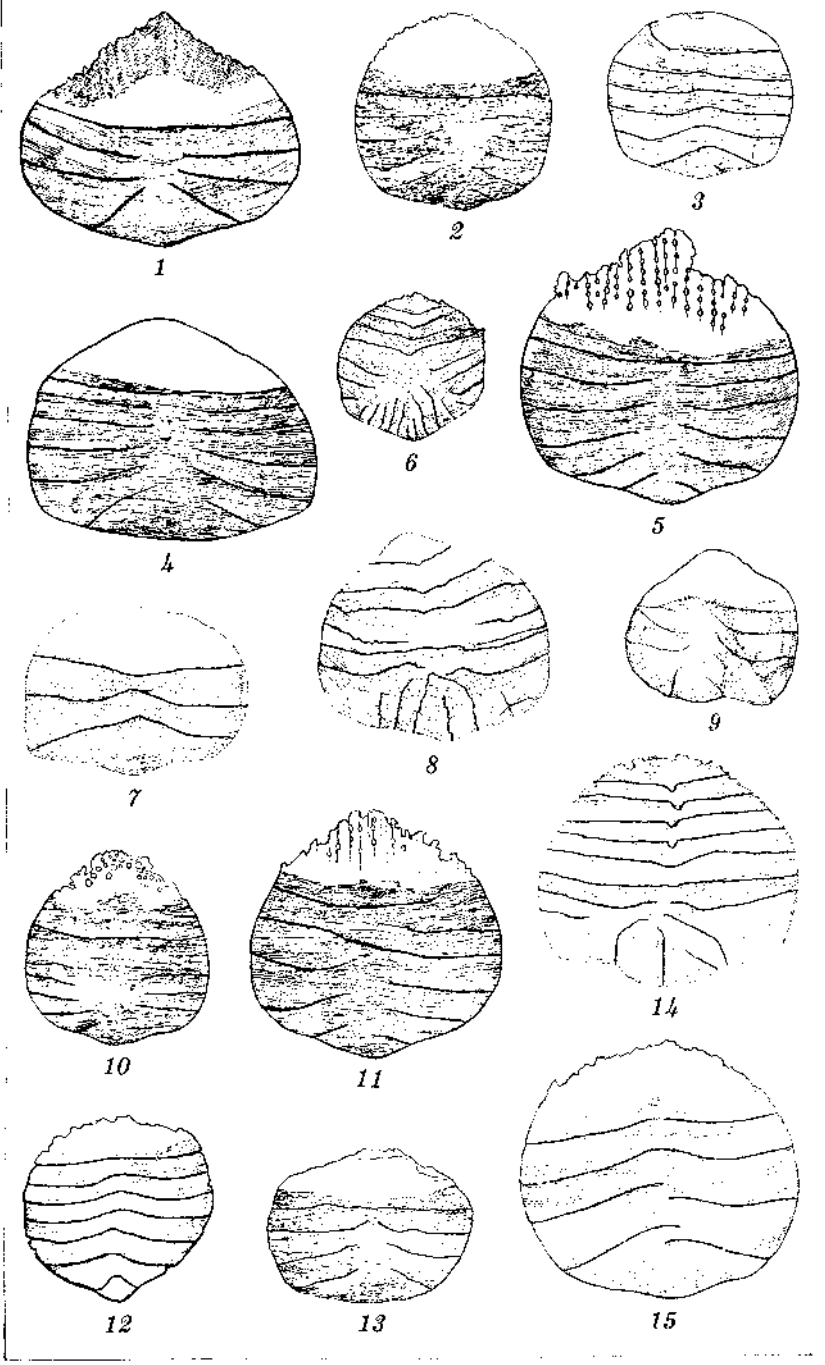
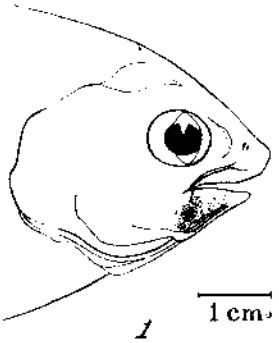


PLATE 2.



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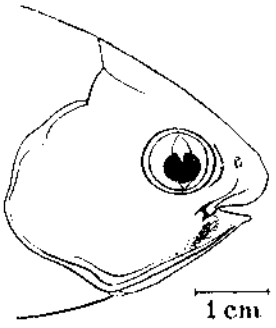

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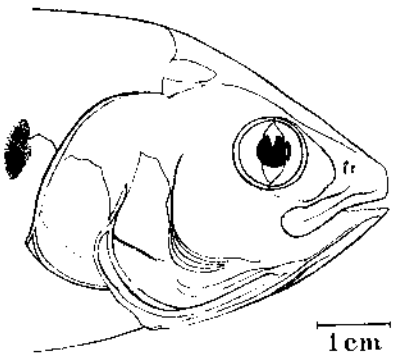

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PLATE 3